ADOBE
DAM/DESERT HILLS

AREA DRAINAGE MASTER PLAN

Part 7

Flood Response Plan

Volume 1

Flood Control District of Maricopa County

June 2005

ADOBE DAM / DESERT HILLS AREA DRAINAGE MASTER PLAN FLOOD RESPONSE PLAN

TECHNICAL MEMORANDUM

Prepared For:
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, AZ 85009
(602) 506-1501

Registered Professional Engineer (Civil)
CERTIFICATE NO.
35895
TED W.
LEHMAN
Date Signed 6-9-05
ARIZONA U.S.A.

Flood Control District of Maricopa County

Registered Professional Engineer (Civil)
CERTIFICATE NO.
14720
PATRICIA K.
QUINN
Date Signed 6/9/05
ARIZONA, U.S.A.

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

JE Fuller/ Hydrology & Geomorphology, Inc.
8400 S. Kyrene Road, Suite 201
Tempe, AZ 85284
(480) 752-2124

June 2005

NOTE:

THE USER SHOULD READ THE ENTIRE FLOOD RESPONSE PLAN CAREFULLY AND SHOULD BE AWARE OF ALL ELEMENTS OF THIS PLAN, INCLUDING STRENGTHS AND LIMITATIONS, AND INDIVIDUAL RESPONSIBILITIES. THE FLOOD WARNING/ RESPONSE PLAN PRESENTED HEREIN AND ON THE EMERGENCY ACCESS MAP, IS USEFUL AS ONE STEP IN DEVELOPING A FLOOD WARNING SYSTEM FOR THE RESIDENTS WITHIN THE ADOBE DAM / DESERT HILLS ADMP STUDY AREA. HOWEVER, THE POSSIBILITY OF INADVERTENT ERROR IN DESIGN OR FAILURE OF EQUIPMENT FUNCTION EXISTS AND MAY PREVENT THE SYSTEM FROM OPERATING PERFECTLY AT ALL TIMES. THEREFORE, NOTHING CONTAINED HEREIN MAY BE CONSTRUED AS A GUARANTEE OF THE SYSTEM OR ITS OPERATION, OR CREATE ANY LIABILITY ON THE PART OF ANY PARTY OR ITS DIRECTORS, OFFICERS, EMPLOYEES OR AGENTS FOR ANY DAMAGE THAT MAY BE ALLEGED TO RESULT FROM THE OPERATION, OR FAILURE TO OPERATE, OF THE SYSTEM OR ANY OF ITS COMPONENT PARTS. THIS CONSTITUTES NOTICE TO ANY AND ALL PERSONS OR PARTIES THAT THE NATIONAL WEATHER SERVICE, FLOOD CONTROL DISTRICT OF MARICOPA COUNTY, MARICOPA COUNTY DEPARTMENT OF EMERGENCY MANAGEMENT, MARICOPA COUNTY SHERIFF'S OFFICE, CITY OF PHOENIX 911 DISPATCH CENTER, CITY OF PHOENIX CENTRAL ALARM, DAISY MOUNTAIN FIRE DEPARTMENT, AND JE FULLER/ HYDROLOGY & GEOMORPHOLOGY, INC. OR ANY OFFICER, AGENT OR EMPLOYEE THEREOF, SHALL NOT BE LIABLE FOR ANY DEATHS, INJURIES, OR DAMAGES OF WHAT EVER KIND THAT MAY RESULT FROM RELIANCE ON THE TERMS AND CONDITIONS OF THIS SYSTEM.

ADOBE DAM / DESERT HILLS AREA DRAINAGE MASTER PLAN
FLOOD RESPONSE PLAN
TECHNICAL MEMORANDUM

TABLE OF CONTENTS

PREFACE ..... **viii**

SECTION 1: INTRODUCTION **10**

1.1 Purpose 10
1.2 Project Location 10
1.3 Study Area Description 12
1.3.1 Hydrology 12
1.3.2 Flood History 13

SECTION 2: FLOOD VULNERABILITY **14**

2.1 General 14
2.2 Roadway Crossing Evaluation 14
2.3 Flood Vulnerable Residences 27
2.4 Lead Time Estimation 31

SECTION 3: FLOOD DETECTION **34**

3.1 Flood Detection Network 34
3.2 Flood Detection Criteria 38
3.2.1 Roadway Drainage Crossings 39
3.2.2 Residents in Floodplain 43
3.2.3 Critical At-Risk Facilities 47
3.2.4 Dam Emergencies – Blue and Purple Alerts 47
Blue Alert – Emergency Spillway Discharges 47
Purple Alert – Dam Failure 49
3.3 Summary and Important Considerations 50
3.4 Flood Prediction Capability 50
3.4.1 District Meteorological Services Program 50
3.4.2 National Weather Service Products 52
3.5 Summary 53

SECTION 4: INFORMATION DISSEMINATION **54**

4.1 Dissemination of NWS and FCDMC Messages 55
4.2 National Weather Service Products 55
4.3 FCDMC Meteorological Services Program (MSP) Messages 56
4.4 Dissemination of Flood Alert Messages 56
4.4.1 Agency Dissemination 56
4.4.2 Public Dissemination 60
4.5 Communications Flowchart 61

SECTION 5: FLOOD WARNING MESSAGE SUITE **63**

SECTION 6: ACTION PLANS **66**

6.1 Agency Action Plans 67
6.2 Evacuation Procedures 67

6.3 Post-Flood Actions 67

SECTION 7: IMPLEMENTATION 69

7.1 Training 69
7.2 Flood Exercises 69
7.3 FRP Updates 71
7.4 FRP Follow-Up 71

SECTION 8: LIMITATIONS 73

SECTION 9: CITED REFERENCES 75

APPENDIX 76

APPENDIX 76

LIST OF TABLES

Table 2-1. Recurrence Interval of Impassable Discharge at Roadway Drainage Crossings & Gage Assignments for Flood Detection 18

Table 2-2. Summary of Flood Vulnerable Residences – FFE vs. BFE 28

Table 3-1. ALERT Stations in the Adobe Dam / Desert Hills Area 37

Table 3-2. Proposed Flood Detection Criteria for Roadway Drainage Crossings 39

Table 3-3. Depth-Duration-Frequency Statistics for Desert Hills Area 40

Table 3-4. Flood Frequency Estimates for FCDMC ALERT Stream Gage Locations 41

Table 3-5. Streamflow Detection Criteria for Roadway Closure Along Skunk Creek 43

Table 3-6. CENS Warning Areas and Gage Assignments 46

Table 3-7. Rainfall Flood Detection Criteria for Blue Alert for Adobe Dam 48

Table 3-8. Summary of Rate of Fall Alarms for Adobe Dam 49

Table 3-9. Summary of Flood Detection Criteria 53

Table 4-1. CENS Warning Areas 58

Table 4-2. Emergency Contact Information 59

Table 5-1. Adobe FRP Flood Warning Message Suite - NWS And FCDMC Warning Messages 64

Table 5-2. Adobe FRP Flood Warning Message Suite 65

LIST OF FIGURES

Figure 1-1. Vicinity Map 11
Figure 2-1: Multiple profile water surface elevations at 16th Street 16
Figure 2-2: Rating curve at 16th Street (Q @ 0.5 ft = 145 cfs) 16
Figure 2-3: Example recurrence interval determination 17
Figure 2-4. Recurrence Interval of Roadway Drainage Crossing Impassibility 26
Figure 2-5. Flood Vulnerable Residences 29
Figure 2-6. Close Up of Flood Vulnerable Residences in Desert Hills Area 30
Figure 3-1. Flood Detection Network 36
Figure 3-2. Assignment of Roadway Drainage Crossings to Gages 42
Figure 3-3. CENS Warning Areas Gage Assignment 44
Figure 3-4. Location of CENS Warning Areas 45
Figure 3-5. Adobe Dam Drawdown Curve 49
Figure 4-1 Communications Flowchart 62

APPENDIX MATERIALS

- **Example CENS Script**
- **Letter to Floodplain Residents Regarding CENS and FRP**
- **Detailed CENS Activation Procedures**

EMERGENCY ACCESS MAP

REFERENCE WALL MAP

CD-ROM

LIST OF ACRONYMS

ADMP	Area Drainage Master Plan
Adobe ADMP	Adobe Dam / Desert Hills Area Drainage Master Plan
ADWR	Arizona Department of Water Resources
ALERT	Automated Local Evaluation in Real Time
BFE	Base Flood Elevation
CP	Concentration Point
CENS	Community Emergency Notification System
COP	City of Phoenix
COPFD	City of Phoenix Fire Department
COPPD	City of Phoenix Police Department
DMFD	Daisy Mountain Fire Department
DMS	Desert Mountain School
District	Flood Control District of Maricopa County
EAM	Emergency Access Map
EAP	Emergency Action Plan
EOP	Emergency Operations Plan
ERM	Emergency Response Manual
FCDMC	Flood Control District of Maricopa County
FDS	Floodplain Delineation Study
FERM	Flood Emergency Response Manual
FFE	Finished Floor Elevation
FRP	Flood Response Plan
JEF	JE Fuller/ Hydrology & Geomorphology, Inc.
MCDEM	Maricopa County Department of Emergency Management
MCDOT	Maricopa County Department of Transportation
MCSO	Maricopa County Sheriff's Office
MSP	Meteorological Services Program
NWS	National Weather Service
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
QPF	Quantitative Precipitation Forecast

SCFRP	Skunk Creek Flood Response Plan
SOP	Standard Operation Procedure
SPF	Standard Project Flood

PREFACE

The Adobe Dam/Desert Hills Area Drainage Master Plan (ADMP) Flood Response Plan (FRP) consists of three primary components, including the Emergency Access Map, Reference Wall Map, and Technical Memorandum. Digital files for all deliverables, including hydrologic and hydraulic models, are provided herein on CD in multiple formats (see Appendix). Digital files are provided to facilitate future updates to the plan and for incorporation into the FCDMC ALERT web site. The FRP is a nonstructural component of the Recommended Alternative for the ADMP. It is presented within the ADMP as Part 7, Volume 1.

Emergency Access Map

The FRP Emergency Access Map includes two separate maps: one showing identified flood vulnerable residents and Community Emergency Notification System (CENS) notification areas, and the second the impassable roadway crossing locations and the flood frequency associated with their impassability. These two maps are provided electronically as separate figures as well as in a single side-by-side format version (see Appendix). The Emergency Access Map is intended for use by the emergency response community, including MCDOT, MCSO, COPPD, COPFD, DMFD, and District personnel.

Reference Wall Map

The Reference Wall Map shows ALERT sensor locations, watershed boundaries, roadway crossings impacted during floods, flood hazard areas, and CENS notification areas. It is intended for use in the DMFD, MCDEM, and the FCDMC ALERT Room for informational purposes during imminent and occurring flood events. The Reference Wall Map is mounted on foam-core board provided under separate cover and is also included folded in a pocket in the Appendix and as a pdf file on the CD-ROM.

Technical Memorandum

This document is the Technical Memorandum and is intended for use by personnel of the FCDMC Flood Warning Branch and Meteorological Services Program (MSP), to support decisions regarding dissemination of flood alert messages, and implementation of the flood response action plans during flood events in the ADMP area.

SECTION 1: INTRODUCTION

1.1 Purpose

The Flood Control District of Maricopa County contracted with JE Fuller/ Hydrology & Geomorphology, Inc. (JEF) to prepare a Flood Response Plan (FRP) as one component of the Adobe Dam / Desert Hills Area Drainage Master Plan (ADMP) (Contract No. FCD2002C001). The purpose of the FRP is to reduce the potential for property damage and loss of life resulting from floods on identified hazardous watercourses. In addition, the FRP was identified as one of the nonstructural elements of the Recommended Alternative in the Adobe ADMP.

The FRP was developed under the guidance of the Flood Control District of Maricopa County (District or FCDMC). In addition, the Maricopa County Department of Transportation (MCDOT), Maricopa County Department of Emergency Management (MCDEM), Maricopa County Sheriff's Office (MCSO), Phoenix Central Alarm, and Daisy Mountain Fire Department (DMFD) provided input about local emergency response resources. The FRP is intended to function independently as a stand-alone document, and to be added as an Appendix to the FCDMC Flood Emergency Response Manual and MCDEM Maricopa County Emergency Operations Plan (2002).

1.2 Project Location

The ADMP study area is located in northern Maricopa County, Arizona and is bounded by New River to the north, Cave Creek to the east, City of Phoenix to the south, and I-17 to the west (Figure 1-1). The development of the area began in the 1940s but residential development has accelerated significantly in the past decade. Most of the development is large single lot residential areas. The area also includes the Maricopa County Cave Creek Regional Park and a large area of the Tonto National Forest.

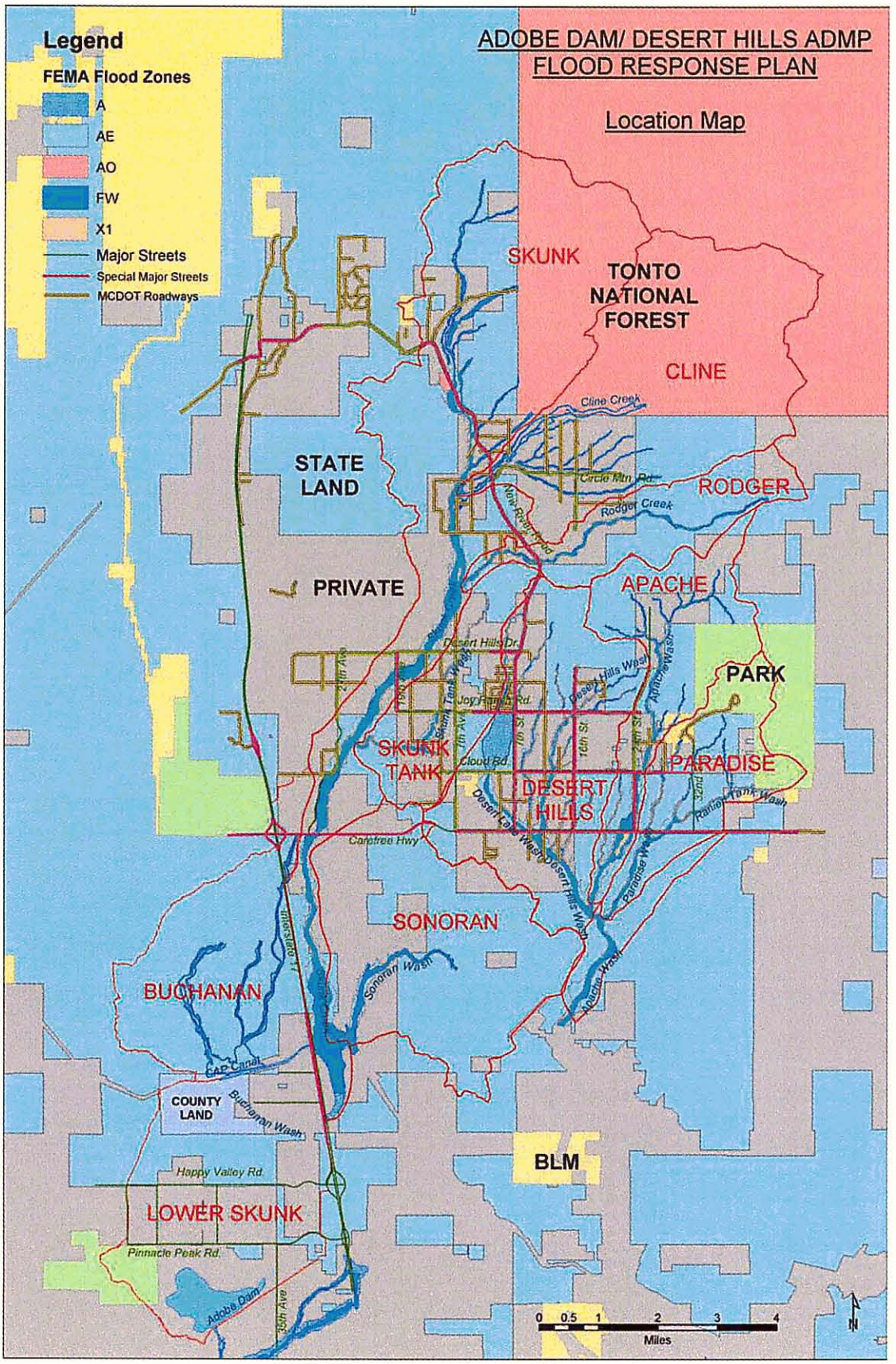


Figure 1-1. Vicinity Map

1.3 Study Area Description

1.3.1 Hydrology

The major watercourses included in the FRP are listed below and shown in Figure 1-1:

- Skunk Creek and its tributaries including:
  - Cline Creek and its tributaries
  - Rodger Creek
  - Skunk Tank Wash
  - Sonoran Wash
  - Buchanan Wash
- Apache Wash and its tributaries including
  - Desert Lake Wash
  - Desert Hills Wash
  - Paradise Wash
  - Raneiri Tank Wash

The Skunk Creek watershed drains to Adobe Dam. The total drainage area of Skunk Creek at Adobe Dam is 86.5 square miles (JEF, 2003). The Adobe Dam was constructed by the U.S. Army Corps of Engineers in 1983. The dam was designed to safely impound the Standard Project Flood (SPF), which has a peak inflow of 66,000 cfs, below the emergency spillway elevation (1377.7 feet; 39.9 ft gage height). The emergency spillway elevation was designed to safely pass the Probable Maximum Flood (PMF) which has a peak inflow of 119,000 cfs and a routed outflow of 12,000 cfs. The 100-year flood results in impoundment with a maximum pool elevation of 1364.1 feet (26.3 ft gage height) (JEF, 2003).

Apache Wash drains to Cave Creek within the flood reservoir pool of Cave Buttes Dam. Apache Wash has a total drainage area of 26.8 square miles at its inflow point to the reservoir pool and represents about 14 percent of the total drainage area to the Cave Buttes Dam.

Flooding in the FRP area typically occurs as a result of two types of seasonal storm events. The first type occurs as high intensity, short duration thunderstorms during the summer monsoon season. The second type occurs as lower intensity, longer duration general winter storms. Flood hydrographs are flashy. That is, flood waters rise and fall rapidly with generally short total flow durations. Typical flood durations are measured in minutes and hours rather than days. Therefore,

the time for emergency response is inherently short but so is the duration of the emergency itself. Nevertheless, post-flood impacts and cleanup could be felt for a much longer period as access is reestablished and properties are cleaned and repaired.

1.3.2 Flood History

Skunk Creek near Interstate 17 is the only long-term stream gage in the area. Streamflows have been monitored there since 1960. Adobe Dam itself has also been monitored since 1983. The 10-year peak discharge according to the USGS based on statistical analysis of the gaging record is 6,120 cfs (Pope & others, 1998). Since 1960, six floods with greater than a 10-year discharge have been recorded. The largest flow was 11,500 cfs and occurred on August 1, 1964. This flow corresponds to about a 20-year flood according to the USGS frequency analysis. The largest flood since the construction of Adobe Dam occurred on August 12, 1990 when a flow of 8,160 cfs was recorded at the USGS gage near I-17. Since construction of the CAP Canal, frequent to moderate floods can be significantly impacted by the large storage areas upstream of the canal embankment. The precise impact of the Canal is not certain. However, the January 1993 flooding produced the maximum observed impoundments at the neighboring New River Dam and Cave Buttes Dam. At New River Dam the estimated frequency of the January impoundment was 45 years. At Cave Buttes Dam, the impoundment frequency was similar. However, at Adobe Dam, the estimated frequency of the January 1993 impoundment was between 2 and 5 years. Given the similar geography and design criteria for these three dams, some other explanation is needed to explain the discrepancy. A possible candidate is the effect of the CAP Canal.

More recently, rainfall in the Desert Hills area on October 10, 2003 demonstrated the impacts of roadway drainage crossings. During that event when 1.65 inches of rain were recorded at the Cline Creek rain gage, a school bus got stuck at the crossing of Desert Lake Wash at Cloud Road. About 1.5 inches fell in a two hour period during that event. This event was equivalent to about a 2- to 5-year rainfall event for the Desert Hills area.

SECTION 2: FLOOD VULNERABILITY

The following section presents the identification and evaluation of flood vulnerabilities in the Adobe ADMP study area. The nature and distribution of the identified vulnerabilities will dictate the type of detection criteria, communication, and emergency response recommended in the FRP.

2.1 General

The categories of flood vulnerabilities in the Adobe FRP area can be defined as follows:

- Roadway crossings
- Floodway residents
- Floodway fringe residents
- Dam Emergencies
  - Spillway discharges
  - Potential dam failure

This flood response plan will address all of these types of flood vulnerability. However, the Dam Emergency categories are more explicitly addressed in the Emergency Action Plan for Adobe Dam which was completed by the District in January 2005.

The roadway crossing hazards and the floodway residence inundation hazards were evaluated as part of the Adobe ADMP (JEF, 2004). The floodway fringe residence inundation hazards were evaluated for the FRP. A brief description of the methods and results of the flood vulnerability assessments follows.

2.2 Roadway Crossing Evaluation

Purpose – Roadway drainage crossings in the area were evaluated for the purpose of quantifying the frequency of the threshold discharge associated with six inches of flow depth over the roadway. Only primary arterial roadways and "gateway" roadway locations were evaluated directly. A "gateway" was defined as a road that serviced at least 5 homes as indicated in the 2002 aerial photography used for the ADMP.

Data Sources – Multiple data sources were utilized for the roadway passability evaluation. Information from existing reports and studies were used to the extent possible. In addition, field investigations were conducted to collect relevant data for a few crossings not evaluated in the previous studies.

Application/Analysis – A threshold flow depth of 0.5 feet at any road crossing was assumed to constitute a potential hazard for vehicle passage. This same threshold has been used in numerous other studies in Maricopa County. The methodology for determining the discharge associated with this threshold depth utilized data from hydrologic and hydraulic models previously prepared as part of the Adobe ADMP and Floodplain Delineation Studies (FDS) by others. Regional regression equations and new watershed delineations were performed for locations without any previous hydrologic data. Stage-discharge rating curves and a flood frequency relationship were established for each arterial crossing. The frequency of the 0.5-foot overtopping discharge was estimated from these relationships. An example of this process is shown in Figures 2-1 and 2-2 below. A complete discussion of the roadway drainage crossing analysis for the arterial streets can be found in the Adobe ADMP, Part 8, Volume 2, Section 4 (JEF, 2004).

Example roadway overtopping analysis – Desert Hills Wash Tributary 2 at 16th St.

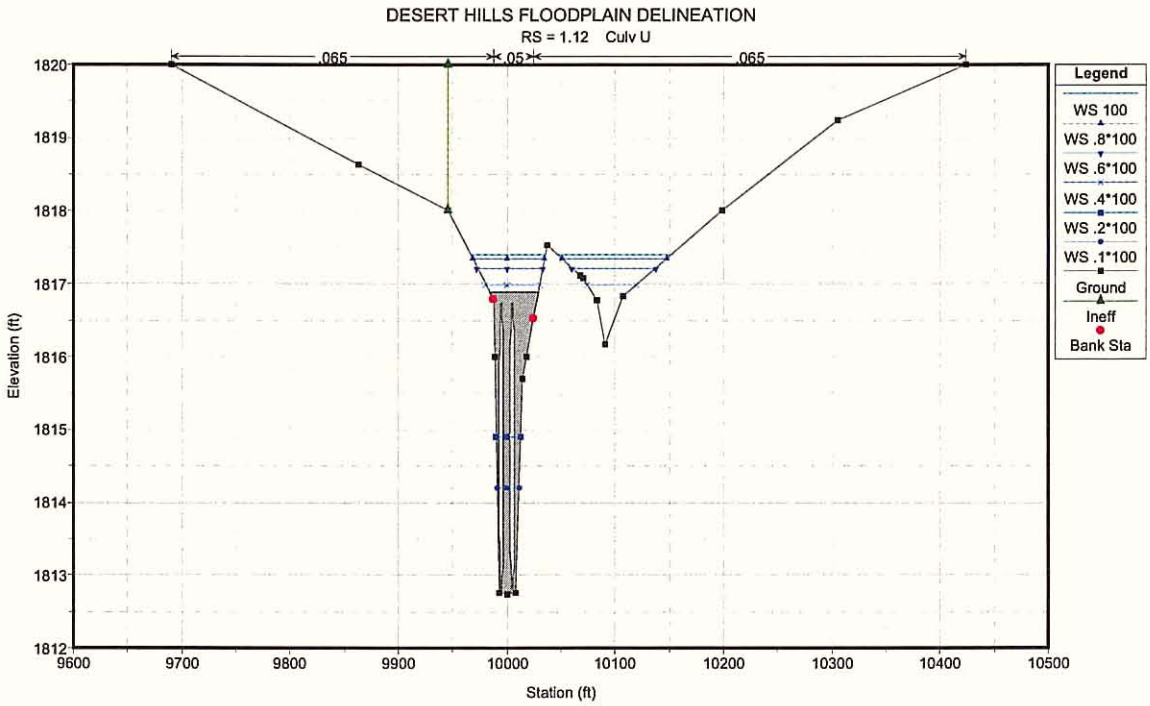


Figure 2-1. Multiple profile water surface elevations at 16th Street

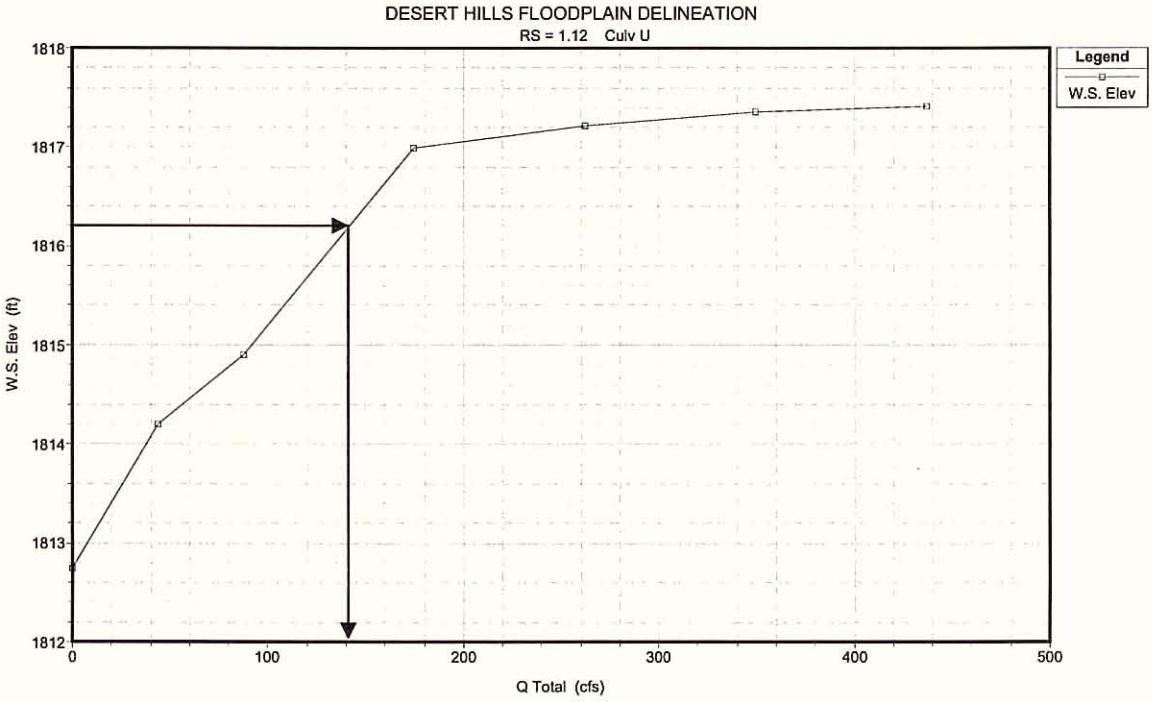


Figure 2-2. Rating curve at 16th Street (Q @ 0.5 ft = 145 cfs)

The 100-year discharge at this location is 437 cfs. The recurrence interval of 145 cfs (the discharge with a depth of 0.5 feet over the roadway) was estimated as a ratio of the 100-year discharge (i.e. 145 / 437 = 0.332). This was converted to a frequency by a relationship developed as part of the floodway residence risk assessment for the ADMP as discussed in Part 8, Volume 2, Section 1. The recurrence interval for the example of Desert Hills Wash Tributary 2 at 16th Street is 9 years and is shown in Figure 2-3 below.

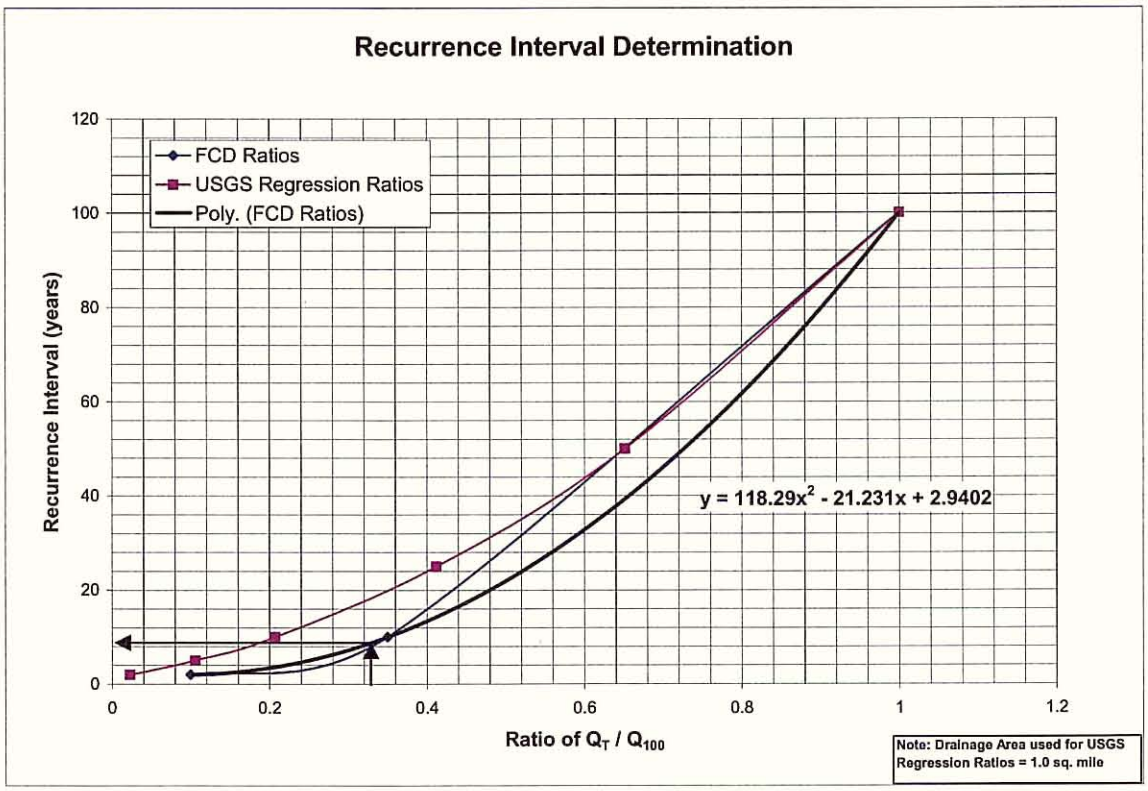


Figure 2-3. Example recurrence interval determination

Interpretation – The recurrence interval of impassability of each flood-impacted crossing was estimated based on the frequency of the flood required to produce the impassable discharge. The frequency estimates are summarized in Table 2-1. All collector and minor street crossings were assigned to the less than 2-year frequency category. The flood detection criteria for various recurrence intervals are discussed in Section 3.

Table 2-1. Recurrence Interval (R.I.) of Impassable Discharge at Roadway Drainage Crossings & Gage Assignments for Flood Detection			
Stream Name	Street Name	R.I. of 0.5 ft Overtopping	Gages for Flood Detection
3rd St to Desert Lake Wash	Carefree Hwy - Eastbound	86	DMS
Apache Wash	24th Street	11	DHW at JRR PT, R, 4890
Apache Wash	Carefree Highway	6	DHW at JRR PT, R, 4890
Apache Wash	Cloud Road	1	DHW at JRR PT, R, 4890
Apache Wash	Maddock Road	1	DHW at JRR PT, R, 4890
Apache Wash	Saddle Mountain Rd	1	DHW at JRR R, PT, 4890
Apache Wash Trib 1	Cloud Road	34	DHW at JRR R, PT
Apache Wash Trib 1	Cloud Road	4	DHW at JRR R, PT
Apache Wash Trib 1	Carefree Highway	> 100	DHW at JRR R, PT
Cline Creek	12th Street	1	5583
Cline Creek	3rd Avenue	10	5583
Cline Creek	6th St and Mano Dr	54	5583
Cline Creek Trib C6	10th Street	1	5580, 5545
Cline Creek Trib C6	12th Street	1	5580, 5545
Cline Creek Trib C6	14th Street	1	5580, 5545
Cline Creek Trib C6	16th Street	1	5580, 5545
Cline Creek Trib C6	22nd Street	1	5580, 5545
Cline Creek Trib C8	10th Street	1	5580
Cline Creek Trib X1	18th St	1	5580, 5545
Cline Creek Trib X1	20th St	1	5580, 5545
Cline Creek Trib X2	18th St	1	5580, 5545
Cline Creek Trib X2	20th St	1	5580, 5545
Cline Creek Trib X2	22nd Street	1	5580, 5545
Cline Creek Trib X2	Johnson Road	1	5580, 5545
Cline Creek Trib X3	14th Street	1	5580, 5545
Cline Creek Trib X3	16th Street	1	5580, 5545
Cline Creek Trib X3	18th St	1	5580, 5545
Cline Creek Trib X3	20th Street	1	5580, 5545
Cline Creek Trib X4A-2	12th Street	1	5580
Cline Creek Trib X4A-3	10th Street	1	5580
Cline Creek Trib X4B	12th Street	1	5580
Cline Creek Trib X4B	Johnson Road	1	5580
Cline Creek Trib X5	10th Street	1	5580
Cline Creek Trib X5	12th Street	1	5580
Cline Wash Trib C8	12th Street	1	5580
Cline Wash Trib C8	14th Street	1	5580
Cline Wash Trib C8	16th Street	1	5580
Cline Wash Trib C8	20th Street	1	5580
Cline Wash Trib C8	Circle Mountain Road	> 100	5580, 5583
Deadman Wash	I-17	> 50	5625
Desert Hills Wash	12th Street	1	DHW at JRR PT, R, DMS
Desert Hills Wash	12th Street	1	DHW at JRR PT, R
Desert Hills Wash	14th Street	1	DHW at JRR PT, R, DMS
Desert Hills Wash	16th Street	1	DHW at JRR R, PT

Table 2-1. Recurrence Interval (R.I.) of Impassable Discharge at Roadway Drainage Crossings & Gage Assignments for Flood Detection			
Stream Name	Street Name	R.I. of 0.5 ft Overtopping	Gages for Flood Detection
Desert Hills Wash	20th Street	1	DHW at JRR R, PT
Desert Hills Wash	Carefree Highway	39	DHW at JRR PT
Desert Hills Wash	Cloud Road	1	DHW at JRR R, PT
Desert Hills Wash	Galvin Road	1	DHW at JRR PT, R
Desert Hills Wash	Joy Ranch Road	7	DHW at JRR R, PT
Desert Hills Wash	unnamed	1	DHW at JRR R, PT
Desert Hills Wash Trib 1	16th Street	49	DHW at JRR R, PT, DMS
Desert Hills Wash Trib 1	Carefree Highway	> 100	DHW at JRR R, PT, DMS
Desert Hills Wash Trib 1	Cloud Road	> 100	DHW at JRR R, PT
Desert Hills Wash Trib 2	16th Street	9	DHW at JRR R, PT
Desert Hills Wash Trib 2	20th Street	1	DHW at JRR R, PT
Desert Hills Wash Trib 2	Carefree Highway	> 100	DHW at JRR R, PT, DMS
Desert Hills Wash Trib 2	Cloud Road	> 100	DHW at JRR R, PT
Desert Hills Wash Trib 3	16th Street	24	DHW at JRR R, PT
Desert Hills Wash Trib 3	20th St	1	DHW at JRR R, PT
Desert Hills Wash Trib 4	16th Street	100	DHW at JRR R, PT
Desert Hills Wash Trib 4 N	14th Street	13	DHW at JRR R, PT
Desert Hills Wash Trib 4 S	14th Street	2	DHW at JRR R, PT
Desert Hills Wash Trib 5	14th Street	1	DHW at JRR R, PT, DMS
Desert Hills Wash Trib 5	Galvin	1	DHW at JRR R, PT
Desert Hills Wash Trib 5	Jor Ranch Road	56	DHW at JRR R, PT
Desert Hills Wash Trib 6	16th Street	11	DHW at JRR R, PT
Desert Hills Wash Trib 6	Joy Ranch Road	5	DHW at JRR R, PT
Desert Lake Wash	3rd Street	1	DHW at JRR PT, R, STW at 7th PT, R, DMS
Desert Lake Wash	7th Street	100	DHW at JRR PT, STW at 7th PT
Desert Lake Wash	Carefree Highway	100	DHW at JRR PT, STW at 7th PT
Desert Lake Wash	Cloud Road	1	DHW at JRR PT, R, STW at 7th PT, R, DMS
Desert Lake Wash	Desert Hills Drive	38	STW at 7th R, PT, DHW at JRR R, PT
Desert Lake Wash	Galvin Street	1	DHW at JRR PT, R, STW at 7th PT, R, DMS
Desert Lake Wash	Irving Road	1	STW at 7th R, PT, DHW at JRR R, PT
Desert Lake Wash	Jordan Lane	1	STW at 7th R, PT, DHW at JRR R, PT
Desert Lake Wash	Joy Ranch	1	STW at 7th R, PT, DHW at JRR R, PT
Desert Lake Wash	Lavitt Road	1	STW at 7th R, PT, DHW at JRR R, PT
Desert Lake Wash	New River Road	97	STW at 7th R, PT, DHW at JRR R, PT
Desert Lake Wash	Tanya Lane	90	STW at 7th R, PT, DHW at JRR R, PT
Desert Lake Wash Trib 2	7th Street	2	STW at 7th R, PT, DHW at JRR R, PT
Desert Lake Wash Trib 2	7th Street / Blue Eagle	1	STW at 7th R, PT, DHW at JRR R, PT
Desert Lake Wash Trib 2	Irvine Road	1	STW at 7th R, PT, DHW at JRR R, PT
Desert Lake Wash Trib 2	Joy Ranch Road	2	STW at 7th R, PT, DHW at JRR R, PT
East Fork Desert Lake Wash	10th Street	20	DHW at JRR PT, R, STW at 7th PT, R, DMS
East Fork Desert Lake Wash	10th Street	1	DHW at JRR PT, R, STW at 7th PT, R, DMS
East Fork Desert Lake Wash	10th Street	1	DHW at JRR PT, R, STW at 7th PT, R, DMS

Table 2-1. Recurrence Interval (R.I.) of Impassable Discharge at Roadway Drainage Crossings & Gage Assignments for Flood Detection			
Stream Name	Street Name	R.I. of 0.5 ft Overtopping	Gages for Flood Detection
East Fork Desert Lake Wash	12th Street	1	STW at 7th R, PT, DHW at JRR R, PT
East Fork Desert Lake Wash	12th Street	2	STW at 7th R, PT, DHW at JRR R, PT
East Fork Desert Lake Wash	Carlise Road	1	DHW at JRR R, PT
East Fork Desert Lake Wash	Cloud Road	1	DHW at JRR PT, R, STW at 7th PT, R, DMS
East Fork Desert Lake Wash	Delores Road	1	DHW at JRR R, PT, STW at 7th R, PT
East Fork Desert Lake Wash	Galvin & 10th Street	1	DHW at JRR PT, R, STW at 7th PT, R, DMS
East Fork Desert Lake Wash	Irvine Road	2	STW at 7th R, PT, DHW at JRR R, PT
East Fork Desert Lake Wash	Joy Ranch Road	84	DHW at JRR R, PT
East Fork Desert Lake Wash	Maddock Road	1	DHW at JRR R, PT
New River	I-17	> 50	USGS 09513780 NEW RIVER NEAR ROCK SPRINGS, AZ.
New River	New River Road	> 50	USGS 09513780 NEW RIVER NEAR ROCK SPRINGS, AZ.
Paradise Wash	32nd Street/Cloud Road	> 100	4890, 4915
Paradise Wash	Carefree Highway	42	4915, 4890, DHW at JRR PT, R
Paradise Wash Left Braid	28th Street	7	DHW at JRR R, PT, 4915
Paradise Wash Trib	32nd Street	> 100	4915, 4890, DWH at JRR R, PT
Paradise Wash West Branch	Carefree Highway	31	DHW at JRR R, PT, 4915
Paradise Wash West Branch	Cloud Road	11	DHW at JRR R, PT, 4915
Ranieri Tank Wash	32nd Street	> 100	4915, 4890
Ranieri Tank Wash T2	Cloud Road	1	4915, 4890, DWH at JRR R, PT
Ranieri Tank Wash T2	Cloud Road	1	4915, 4890, DWH at JRR R, PT
Rodger Creek	3rd Street	1	5545, 4920, 5580, 5583, DHW at JRR PT, STW PT
Rodger Creek	New River Road	2	5545, 4920, 5580, 5583, DHW at JRR PT, STW PT
Skunk Creek	19th Avenue	1	5588, 5583, 5588+5583
Skunk Creek	35th Ave.	20	5568, Skunk at DVR PT
Skunk Creek	3rd Avenue	1	5583
Skunk Creek	Carefree Highway	> 100	Skunk at DVR PT
Skunk Creek	Circle Mountain Road	1	5580, 5545, 5555, 5585, 5588, 5583
Skunk Creek	Cloud Road	12	5588, 5583, 5588+5583(+STW PT), Skunk at DVR PT
Skunk Creek	Cloud/27th Ave	12	5588, 5583, 5588+5583(+STW PT), Skunk at DVR PT
Skunk Creek	Desert Hills Drive	1	5588, 5583, 5588+5583
Skunk Creek	Fig Springs Road	1	5555, 5585, 5588
Skunk Creek	Happy Valley Road	100	5568, Skunk at DVR PT
Skunk Creek	Honda Bow	1	5588, 5583, 5588+5583
Skunk Creek	I-17	> 100	5568, Skunk at DVR PT
Skunk Creek	I-17	50	Skunk at DVR PT, 5568
Skunk Creek	New River Road	12	5583
Skunk Creek	no name	1	5555, 5585, 5588
Skunk Creek	Pinnacle Peak Rd.	20	5568, Skunk at DVR PT
Skunk Creek	Pinnacle Peak Rd	20	5568, Skunk at DVR PT

Table 2-1. Recurrence Interval (R.I.) of Impassable Discharge at Roadway Drainage Crossings & Gage Assignments for Flood Detection			
Stream Name	Street Name	R.I. of 0.5 ft Overtopping	Gages for Flood Detection
Skunk Creek	Shangri-la Lane	1	5580, 5545, 5555, 5585, 5588, 5583
Skunk Creek	unknown	1	5555, 5585, 5588
Skunk Creek	unknown	1	5555, 5585, 5588
Skunk Creek	Wolftrap Road	1	5555, 5585, 5588
Skunk Creek	Zorillo Road	1	5588, 5585, 5555
Skunk Creek Trib 10A	New River Road	24	5585, 5580, 5588, 5583
Skunk Creek Trib 10B	Venado Dr	1	5580, 5545, 5555, 5585, 5588, 5583
Skunk Creek Trib 12	6th Street	1	5580, 5545, 5555, 5585, 5588, 5583
Skunk Creek Trib 12	New River Road	4	5580, 5545, 5555, 5585, 5588, 5583
Skunk Creek Trib 12	Sabrose Drive	1	5580, 5545, 5555, 5585, 5588, 5583
Skunk Creek Trib 12	Unnamed	1	5580, 5545, 5555, 5585, 5588, 5583
Skunk Creek Trib 6B	unknown	1	5555, 5585, 5588
Skunk Creek Trib10B	New River Road	5	5580, 5545, 5555, 5585, 5588, 5583
Skunk Tank Wash	11th Ave	4	STW at 7th R, PT
Skunk Tank Wash	11th Ave	1	STW at 7th R, PT
Skunk Tank Wash	11th Ave	1	STW at 7th R, PT
Skunk Tank Wash	15th Ave & Maddock	1	STW at 7th R, PT, DMS
Skunk Tank Wash	17th Ave	1	STW at 7th R, PT, DMS
Skunk Tank Wash	19th Ave	1	STW at 7th R, PT, DMS
Skunk Tank Wash	7th Ave	5	STW at 7th R, PT
Skunk Tank Wash	Desert Hills Drive	7	STW at 7th R, PT
Skunk Tank Wash	Irvine Road	1	STW at 7th R, PT
Skunk Tank Wash	Joy Ranch Road	4	STW at 7th R, PT
Skunk Tank Wash	Saddle Mountain Rd	1	STW at 7th R, PT
trib to Desert Hills Wash Trib 1	22nd Street	1	DHW at JRR R, PT
Tributary Valley Wash, Skunk Tank Wash	11th Ave	1	STW at 7th R, PT, DMS
Tributary Valley Wash, Skunk Tank Wash	15th Ave	1	STW at 7th R, PT, DMS
unnamed	12th St	2	DMS
unnamed	14th St	1	5580
unnamed	15th Ave	> 100	DMS
unnamed	15th Ave	1	5555, 5585, 5588
unnamed	16th Street	> 100	DHW at JRR R, PT
unnamed	16th Street	> 100	DHW at JRR R, PT
unnamed	3rd Street	1	5580, STW at 7th R
unnamed	7th Avenue	10	DMS
unnamed	Carefree Highway	> 100	4915, DHW at JRR R, DMS
unnamed	Carefree Highway	77	DHW at JRR R, PT, DMS
unnamed	Carefree Highway	> 50	DMS, Skunk at DVR R
unnamed	Carefree Highway	> 50	DMS, Skunk at DVR R
unnamed	Carefree Highway	> 50	DMS, Skunk at DVR R
unnamed	Carefree Highway	> 50	DMS, Skunk at DVR R
unnamed	Carefree Highway	> 50	DMS, Skunk at DVR R
unnamed	Carefree Highway	> 50	DMS, Skunk at DVR R
unnamed	Carefree Highway	> 100	DMS
unnamed	Carefree Highway	> 100	DMS

Table 2-1. Recurrence Interval (R.I.) of Impassable Discharge at Roadway Drainage Crossings & Gage Assignments for Flood Detection			
Stream Name	Street Name	R.I. of 0.5 ft Overtopping	Gages for Flood Detection
unnamed	Carefree Highway	> 100	DMS
unnamed	Carefree Highway	> 100	DMS
unnamed	Carefree Highway	50	Skunk at DVR R, DMS, STW at 7th R
unnamed	Cavalry	1	5580
unnamed	Central Ave	100	DMS
unnamed	Central Ave	8	STW at 7th R, PT, DHW at JRR R, PT
unnamed	Central Ave	1	5580, STW at 7th R
unnamed	Central Ave	1	STW at 7th R, PT
unnamed	Circle Mountain Rd	> 100	5580
unnamed	Circle Mountain Rd	> 100	5583
unnamed	Cloud Road	> 100	Skunk at DVR R, DMS, STW at 7th R
unnamed	Cloud Road	100	Skunk at DVR R, DMS, STW at 7th R
unnamed	Cloud Road	100	Skunk at DVR R, DMS, STW at 7th R
unnamed	Cloud Road	100	Skunk at DVR R, DMS, STW at 7th R
unnamed	Cloud Road	100	Skunk at DVR R, DMS, STW at 7th R
unnamed	Cloud Road	38	4915, 4890, DWH at JRR R, PT
unnamed	Cloud Road	10	DHW at JRR R, PT
unnamed	Cloud Road	15	DHW at JRR R, PT, DMS
unnamed	Desert Hills Drive	> 100	STW at 7th R, PT, DHW at JRR R, PT
unnamed	Desert Hills Drive	> 100	STW at 7th R, PT
unnamed	Gibbons Rd	1	5585, 5588
unnamed	Happy Valley Rd	100	5535, 5565, 5610
unnamed	Happy Valley Road	> 100	5565
unnamed	Happy Valley Road	> 100	5535, 5565, 5610
unnamed	Happy Valley Road	90	5565
unnamed	Honda Bow Road	> 100	5580, STW at 7th R
unnamed	Honda Bow Road	13	5580, STW at 7th R
unnamed	Honda Bow Road	> 100	5580, STW at 7th R
unnamed	Honda Bow Road	> 100	5580, STW at 7th R
unnamed	Honda Bow Road	15	5580, STW at 7th R
unnamed	Honda Bow Road	> 100	5580, STW at 7th R
unnamed	I-17	> 100	Skunk at DVR R, DMS, STW at 7th R
unnamed	I-17	> 50	5625
unnamed	I-17	> 50	5625
unnamed	I-17	> 50	5625
unnamed	I-17	> 50	STW at 7th PT
unnamed	I-17	> 50	STW at 7th R, PT, Skunk at DVR R
unnamed	I-17	> 50	STW at 7th R, PT, Skunk at DVR R
unnamed	I-17	> 50	Skunk at DVR R, DMS, STW at 7th R
unnamed	I-17	> 50	Skunk at DVR R, DMS, STW at 7th R
unnamed	Joy Ranch & 24th Street	> 100	DHW at JRR R, PT
unnamed	Joy Ranch Road	> 100	DHW at JRR R, PT
unnamed	New River Road	> 100	5585

Table 2-1. Recurrence Interval (R.I.) of Impassable Discharge at Roadway Drainage Crossings & Gage Assignments for Flood Detection			
Stream Name	Street Name	R.I. of 0.5 ft Overtopping	Gages for Flood Detection
unnamed	New River Road	> 100	5583
unnamed	New River Road	> 100	STW at 7th R, PT, DHW at JRR R, PT
unnamed	New River Road	> 100	5555, 5585, 5583
unnamed	New River Road	46	5555, 5585, 5583
unnamed	New River Road	64	5555, 5585, 5583
unnamed	New River Road	5	5555, 5585, 5625, 5588
unnamed	New River Road	25	5555, 5585, 5583
unnamed	New River Road	> 100	5555, 5585, 5583
unnamed	New River Road	46	5555, 5585, 5583
unnamed	New River Road	33	5580, STW at 7th R
unnamed	New River Road	> 100	5580, STW at 7th R
unnamed	New River Road	> 50	5625, 5585
unnamed	New River Road	> 100	5580, STW at 7th R
unnamed	New River Road	> 100	5580, STW at 7th R
unnamed	New River Road	100	5625, 5585
unnamed	Pinnacle Peak Rd	100	5535, 5565
unnamed	Pinnacle Peak Rd	> 100	5535, 5565
unnamed	Pinnacle Peak Rd	11	5535, 5565, 5610
unnamed	Pinnacle Vista	> 100	5565
unnamed	Pinnacle Vista	1	5565
unnamed	Pinnacle Vista	1	5565
unnamed	Saddle Mountain Rd	1	STW at 7th R, PT
unnamed	Via Puzzola	100	Skunk at DVR R, DMS, STW at 7th R
unnamed	Dolores Road	23	DHW at JRR R, PT
unnamed Desert Hills Wash trib	Irvine Road	2	DHW at JRR R, PT
unnamed Desert Hills Wash trib	Irvine Road	2	DHW at JRR R, PT
unnamed trib Deadman Wash	27th Ave	32	STW at 7th R, PT, Skunk at DVR R
unnamed trib Deadman Wash	29th Ave	2	STW at 7th R, PT, Skunk at DVR R
unnamed trib Deadman Wash	31st Ave	2	STW at 7th R, PT, Skunk at DVR R
unnamed trib Deadman Wash	33rd Ave	1	STW at 7th R, PT, Skunk at DVR R
unnamed trib Deadman Wash	Irvine Road	2	STW at 7th R, PT, Skunk at DVR R
unnamed trib Deadman Wash	Irvine Road	78	STW at 7th R, PT, Skunk at DVR R
unnamed trib Desert Hills Wash	10th St	5	DMS
unnamed trib Desert Hills Wash	Carefree Hwy	> 100	DMS, DHW at JRR R
unnamed trib Desert Hills Wash	Central Ave	100	DMS
unnamed trib Desert Hills Wash	Galvin Street	1	DHW at JRR R, PT, DMS
unnamed trib Desert Lake Wash	3rd Avenue	57	DMS
unnamed trib Desert Lake Wash	3rd Street	2	DMS
unnamed trib Desert Lake Wash	Central Ave	10	DMS
unnamed trib Desert Lake	Central Ave	62	DMS

Table 2-1. Recurrence Interval (R.I.) of Impassable Discharge at Roadway Drainage Crossings & Gage Assignments for Flood Detection			
Stream Name	Street Name	R.I. of 0.5 ft Overtopping	Gages for Flood Detection
Wash			
unnamed trib Desert Lake Wash	Cloud Road	1	DMS
unnamed trib Desert Lake Wash	Cloud Road	70	DMS
unnamed trib Desert Lake Wash	Galvin Street	58	DMS
unnamed trib EF Desert Lake Wash	10th Street	42	STW at 7th R, PT, DHW at JRR R, PT
unnamed trib EF Desert Lake Wash	Carlise Road	1	DHW at JRR R, PT, STW at 7th R, PT
unnamed trib EF Desert Lake Wash	Joy Ranch Road	70	STW at 7th R, PT, DHW at JRR R, PT
unnamed trib EF Desert Lake Wash	Maddock Road	3	DHW at JRR R, PT, STW at 7th R, PT
unnamed trib Skunk Tank Wash	11th Ave	1	STW at 7th R, PT, DMS
unnamed trib Skunk Tank Wash	11th Ave	1	STW at 7th R, PT, DMS
unnamed trib Skunk Tank Wash	15th Ave	10	STW at 7th R, PT
unnamed trib Skunk Tank Wash	17th Ave	3	STW at 7th R, PT
unnamed trib Skunk Tank Wash	7th Ave	15	STW at 7th R, PT
unnamed trib Skunk Tank Wash	7th Ave	25	STW at 7th R, PT, DMS
unnamed trib Skunk Tank Wash	7th Ave	25	STW at 7th R, PT, DMS
unnamed trib Skunk Tank Wash	7th Ave	> 100	STW at 7th R, PT, DMS
unnamed trib Skunk Tank Wash	Cloud Road	13	DMS
unnamed trib Skunk Tank Wash	Cloud Road	100	STW at 7th R, PT
unnamed trib Skunk Tank Wash	Cloud Road	1	DMS
unnamed trib Skunk Tank Wash	Joy Ranch & 7th Ave	7	STW at 7th R, PT, DMS
unnamed trib Skunk Tank Wash	Joy Ranch Rd	> 100	STW at 7th R, PT
unnamed trib Skunk Tank Wash	Joy Ranch Road	4	STW at 7th R, PT, DHW at JRR R, PT
unnamed trib Skunk Tank Wash	Joy Ranch Road	2	STW at 7th R, PT, DMS
unnamed trib Skunk Tank Wash	Maddock Rd	3	STW at 7th R, PT
unnamed trib Skunk Tank Wash	Maddock Rd	1	STW at 7th R, PT, DMS
West Fork Apache Wash	26th Street	5	DHW at JRR R, PT

Results – Results of the roadway crossing evaluations are provided in Table 2-1 and illustrated on Figure 2-4 (Recurrence Interval of Roadway Drainage Crossing Impassability). They show that numerous roadways are closed by less than the two-year event. Many of those roads are smaller local streets. However, even along the major arterial streets some crossings become impassable for events less than the 10-year event.

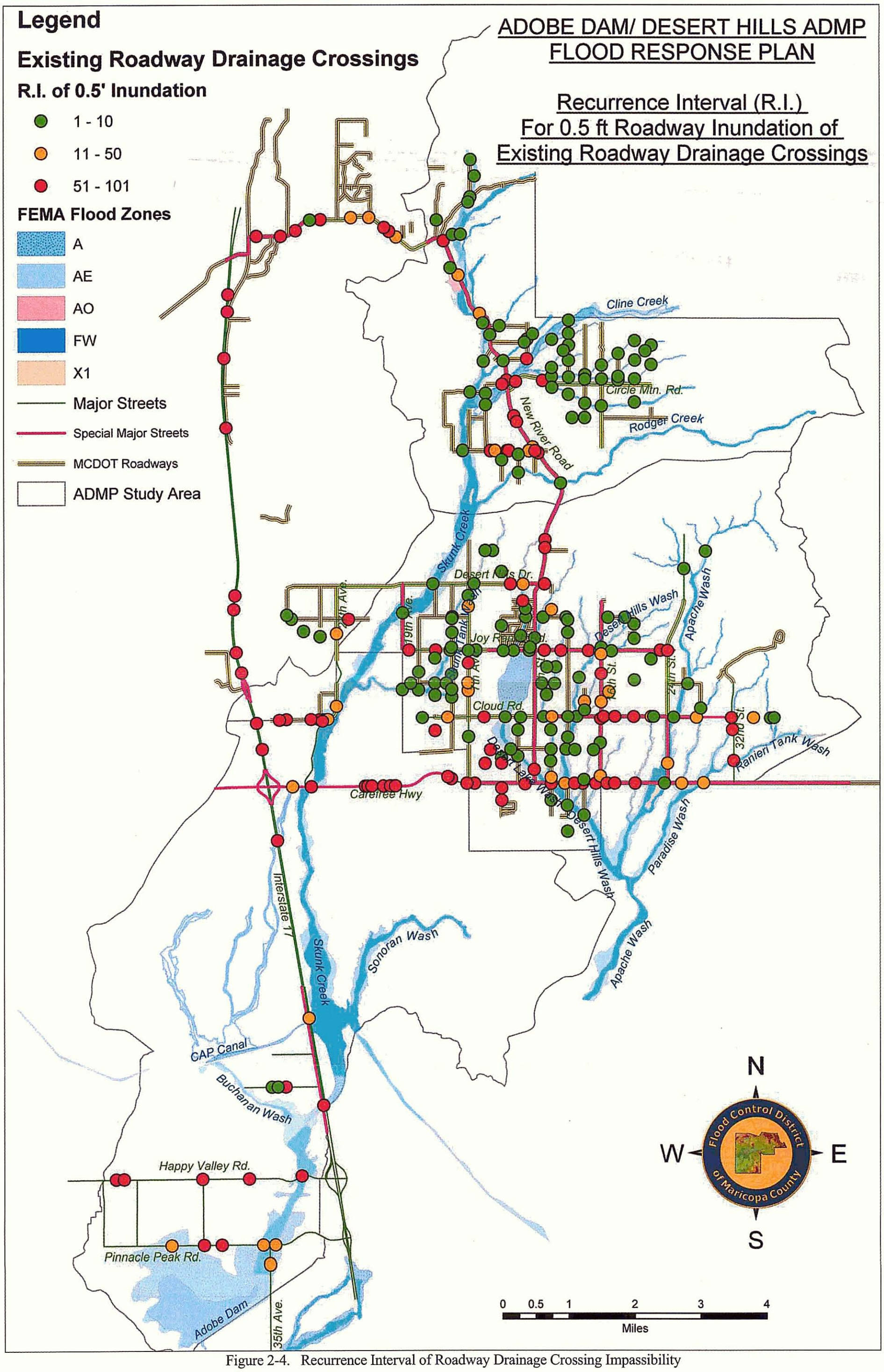


Figure 2-4. Recurrence Interval of Roadway Drainage Crossing Impassibility

2.3 Flood Vulnerable Residences

Purpose – In addition to overtopping of roadway crossings, inundation of occupied residential structures during flood events creates potentially life-threatening hazards. The FRP addresses both identification and notification procedures for flood vulnerable structures. Residents from flood impacted structures will be notified by the Community Emergency Notification System (CENS) as discussed in Sections 3 and 4.

Data Sources – Data used to identify flood vulnerable structures are generally the same as those used for the roadway crossing analyses. Only residences within delineated FEMA floodplains were identified. The delineated floodplains were those developed prior to or as part of the Adobe Dam/ Desert Hills ADMP. Occupied buildings were interpreted from detailed aerial photographs dated February 2002.

In addition, for the floodway residences and many of the floodplain residences, finished floor elevations (FFE) were available from previous surveys for elevation certificates or as part of the ADMP risk assessment evaluation. These data were used to help in selection of the flood detection criteria for flood vulnerable structures.

Application/Analysis – A detailed discussion of the methods used to identify and evaluate the floodway residences was presented in the ADMP, Part 8, Volume 2, Section 1 (JEF, 2003). The floodplain residences were added to the group of flood vulnerable structures for the FRP.

Digital floodplain boundaries were overlain on the Feb. 2002 digital aerial photographs in GIS. Visual evidence in the aerial photos along with attribute data from the Maricopa County Assessor's parcel data base were used to identify occupied structures, called here residences for distinction from other out-buildings such as sheds, barns, etc. For those floodplain residences with elevation certificates, finished floor and base flood elevations (BFE) were compared. Table 2-2 summarizes the results of this comparison.

Table 2-2. Summary of Flood Vulnerable Residences – FFE vs. BFE			
	Fringe	Floodway	Total
Status	No.	No.	No.
At or below BFE	17	16	33
=< 1 ft above BFE	35	14	49
1-2 ft above BFE	30	6	36
> 2 ft above BFE	22	7	29
Undetermined	129	2	131
Total in Fringe	233	41	274

About half of the flood vulnerable residences have no finished floor data. However, it assumed that the distribution is similar to those for which data do exist.

Figure 2-5 shows a spatial summary of the location of flood vulnerable residences and their spatial distribution relative to their depth of flooding in the 100-year flood. Figure 2-6 shows a close up of the Desert Hills Area flood vulnerable residences along with the FLO-2D inundation area results from the ADMP. Note the large concentration of flood vulnerable residences on Desert Lake and Desert Hills Washes. Also notice the general clustered nature of the flood vulnerable residences locations. This characteristic will become important in the definition of warning areas for use in the CENS information dissemination as described later in this report.

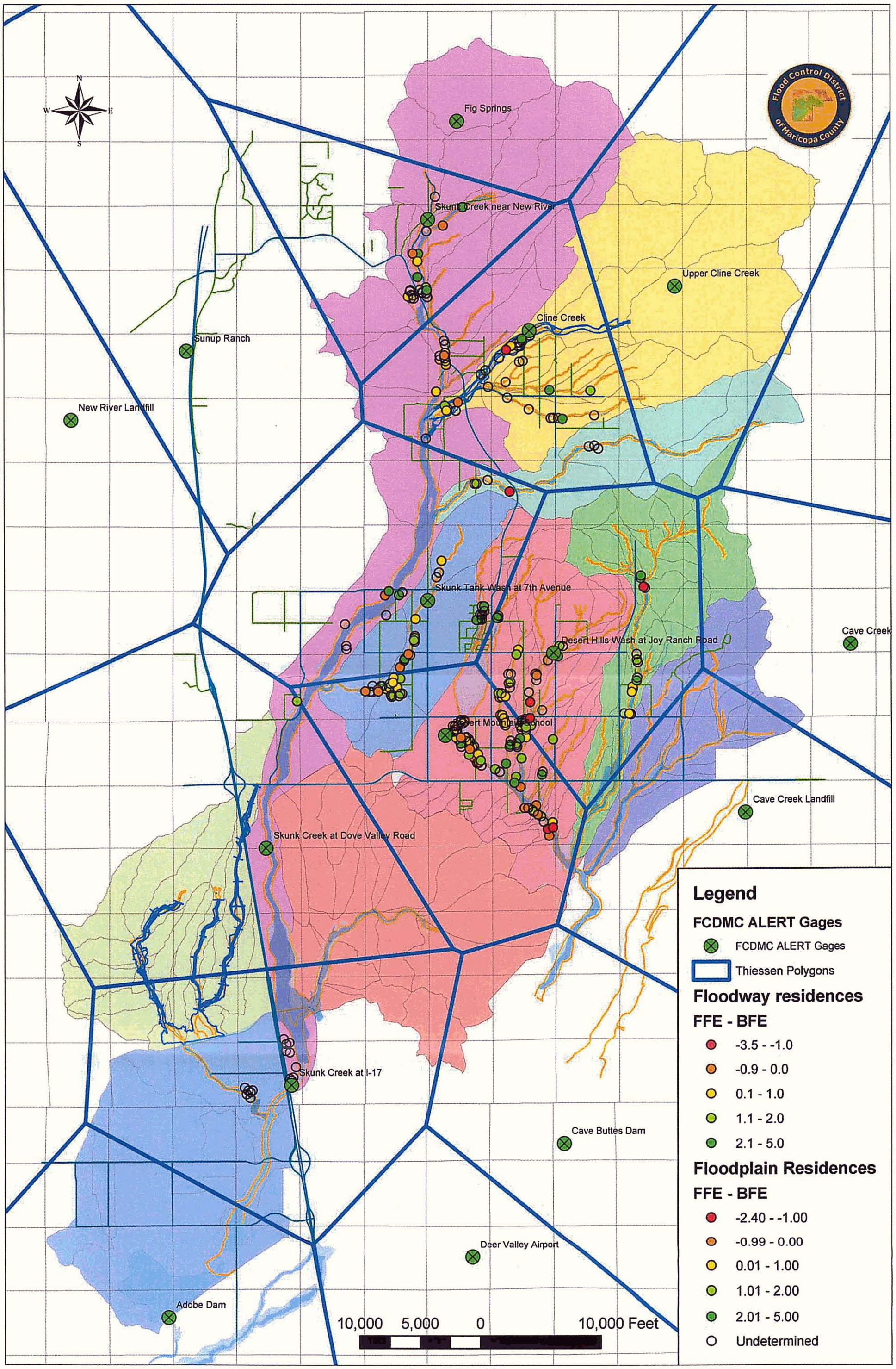


Figure 2-5. Flood Vulnerable Residences

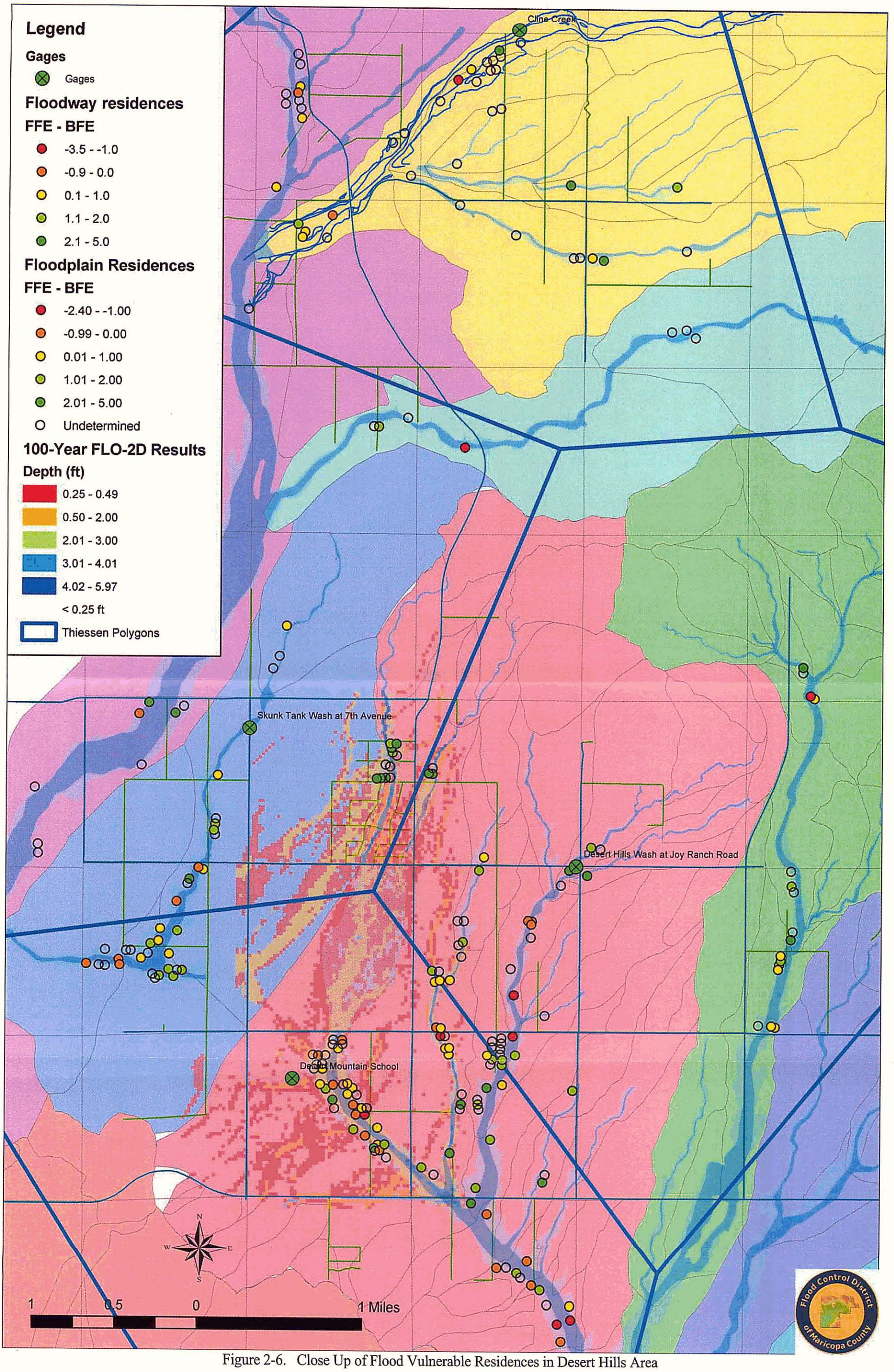


Figure 2-6. Close Up of Flood Vulnerable Residences in Desert Hills Area

2.4 Lead Time Estimation

The results of the effective lead time analysis from previous flood response plans lead to the following conclusions about flood detection criteria and emergency preparedness in the development of the Adobe FRP:

1. A prediction-based FRP is not recommended due to the likelihood for false positive flood warnings. However, existing predictive tools such as the NWS and MSP forecast products should be utilized to raise agency awareness that the issuance of flood alerts and the implementation of emergency action plans may become necessary.

2. A detection-based FRP is recommended. Reports of heavy rainfall or critical water levels in watercourses from observers in the field should take precedence over measured data. Given the rapid response times for the watersheds affecting the area, rainfall detection thresholds need to be set so as to trigger flood alerts before the end of the total storm rainfall. Similarly, flood alerts based upon water levels at stream gages need to be triggered before critical thresholds are reached in order to provide emergency response time.

3. Emergency response times must be minimized by:

   a) an efficient and reliable means of dissemination of flood warnings and updates to response agencies and the public;

   b) emergency action plans that are streamlined with responsibilities that are clearly understood; and

   c) proper training for key personnel for all FRP agencies and regular flood exercises.

4. Recommended improvements and updates to the Flood Response Plan can serve to optimize effective lead times to the extent possible given the constraints of the physical hydrologic system.

Hydrologic Lead Time

Hydrologic lead time is defined as the time between the flood producing rainfall and the arrival of the flood wave at the point of interest.

Results of effective lead time analysis for other FRPs show negative or nearly zero time to respond to rainfall detection based flood detection. Basin response times from the center of rainfall intensity to the Fig Springs and Cline Creek gage performed for the Skunk Creek FRP were about 20 minutes. Basin response times for Skunk Tank Wash and the Desert Hills area are assumed to be similar.

Travel time to Desert Hills Drive from the stream gages was estimated at about 45 minutes for both Cline Creek and Skunk Creek. That is, for flood detection at these stream gages, about 45 minutes will pass before the flood peak reaches Desert Hills Drive. Assuming similar velocities, an additional 45 to 60 minutes would be expected to travel to the CAP.

Most of the flood vulnerable structures identified lie within the 20-minute basin response time areas. Only the Desert Hills Drive area and the Interstate 17 area groups may have additional time to respond. For those two areas, hydrologic lead time is estimated at about one and two hours respectively.

Response Time

The emergency response time is determined by the decision time needed to assess the flood event and issue warnings, and by the readiness of the local emergency response agencies to implement the appropriate action protocols.

The decision time refers to the amount of time required by the dispatch/emergency personnel to:

1. verify that a flash flood or flooding problem is imminent based on prediction tools <u>or</u> that flooding is occurring based on detection data;
2. identify the relative magnitude of the flooding event based on pre-determined criteria; and

3. issue the appropriate alert warning to local response agencies so that the applicable FRP action plans may be triggered.

In effect, the decision time is a measure of the amount of time required by emergency response personnel to verify that a problem exists and to issue a warning. The action time component is the sum of the time required by the response agencies to acknowledge and respond to the flood alert messages, commit resources to the various components of the action plans, and to implement the appropriate response action.

Both decision and action times are estimated for local flood emergency response capabilities based on information provided to JEF during discussions with personnel of the FCDMC Flood Warning Branch, Phoenix Fire Alarm, Daisy Mountain Fire Department, Maricopa County Sheriff's Office, Maricopa County Department of Transportation, and City of Phoenix Street Maintenance. The resulting decision times are estimated to range from 15 to 20 minutes. Action times range from a about 10 minutes to a maximum of more than 90 minutes depending on responder and response location.

Response times will be greatly impacted by roadway closures. Impassability of Desert Hills Drive and 19th Avenue at Skunk Creek to even frequent flood events will increase the driving distance for responders east of Skunk Creek. Similarly, closure of 7th Street/ New River Road at various locations along its length will increase response times in many areas. In some cases, access will be cut off until flooding subsides.

Effective Lead Time

The amount of the effective lead time for a particular watershed depends on the relative balance of the rate of response to flood-generating rainfall– or "flashiness" – of the physical system to the time required for emergency responders to implement flood response activities. Based on the discussion of hydrologic lead time and response time above, the effective lead time for the Adobe FRP area is less than zero for most of the flood vulnerabilities.

Interpretation

For roadway drainage crossings, response to flood vulnerability will rely primarily on the behavior of individual motorists. Emergency responders can utilize the impassability information to avoid

roadway crossings of greatest concern. Conversely, agencies with roadway barricading responsibilities can utilize the vulnerability data to prioritize and advance plan for barricade placement. Some lead time is available for warning of closure of Desert Hills Drive, 19th Avenue, Pinnacle Peak Road, and I-17 on Skunk Creek in particular. Emergency responders should consider the possibility that response times will increase, resources could be cut off from access, and some areas may not be accessible at all until flood levels diminish.

For flood vulnerable residences, reliance on the CENS system and education of residents will be critical components of their safe response to a flood emergency. While the phone system can reach large groups of people relatively swiftly, the amount of time to react will be little to none. Residents will need to be educated about the short time available so that they focus their attention on their personal safety.

SECTION 3: FLOOD DETECTION

Flood detection in the Adobe FRP area will be based on the existing and proposed flood detection network (Section 3.1). Detection is focused on providing information regarding the flood vulnerability groups discussed in Section 2. Flood detection is a balance between time and accuracy. While the prediction of a flood provides residents and emergency responders more time to prepare and react, prediction also contains a high level of uncertainty or potential for false alarms. On the other extreme, direct observation of flooding provides a high level of certainty regarding the occurrence of flooding, but leaves much less time to respond. The flood detection criteria selected for the Adobe FRP attempt to balance these extremes.

3.1 Flood Detection Network

Figure 3-1 shows the existing and proposed flood detection network for the Adobe Dam/ Desert Hills ADMP area. Land ownership is also shown for reference. The existing flood detection network consists of six rain gages located within the watershed and an additional six in the surrounding area. Four water level sensors are co-located with rain gages in the watershed – two on Skunk Creek, one on Cline Creek, and the fourth on Adobe Dam itself.

The proposed ALERT stations fill a previously ungaged area between Adobe Dam and upper Skunk Creek. Four new locations are proposed including three rain/stream sites, and one weather station at

Desert Mountain School (DMS). Of the three proposed water level sensors, one is proposed for Skunk Tank Wash at 7th Avenue, one on Desert Hills Wash at Joy Ranch Road, and the third, on Skunk Creek at the Dove Valley Road alignment (future bridge site). The new stations' purpose is to provide detection and verification of flood producing rainfall and consequent runoff for areas with extensive or special flood vulnerable structures and/or residences. In particular, the new gages will provide detection of potential closure for Interstate 17 and warning of flood vulnerable residences on Skunk Tank, Desert Lake, and Desert Hills Washes.

Table 3-1 gives a list of both the existing and proposed ALERT stations and instruments. Stations without IDs in the table are the proposed stations.

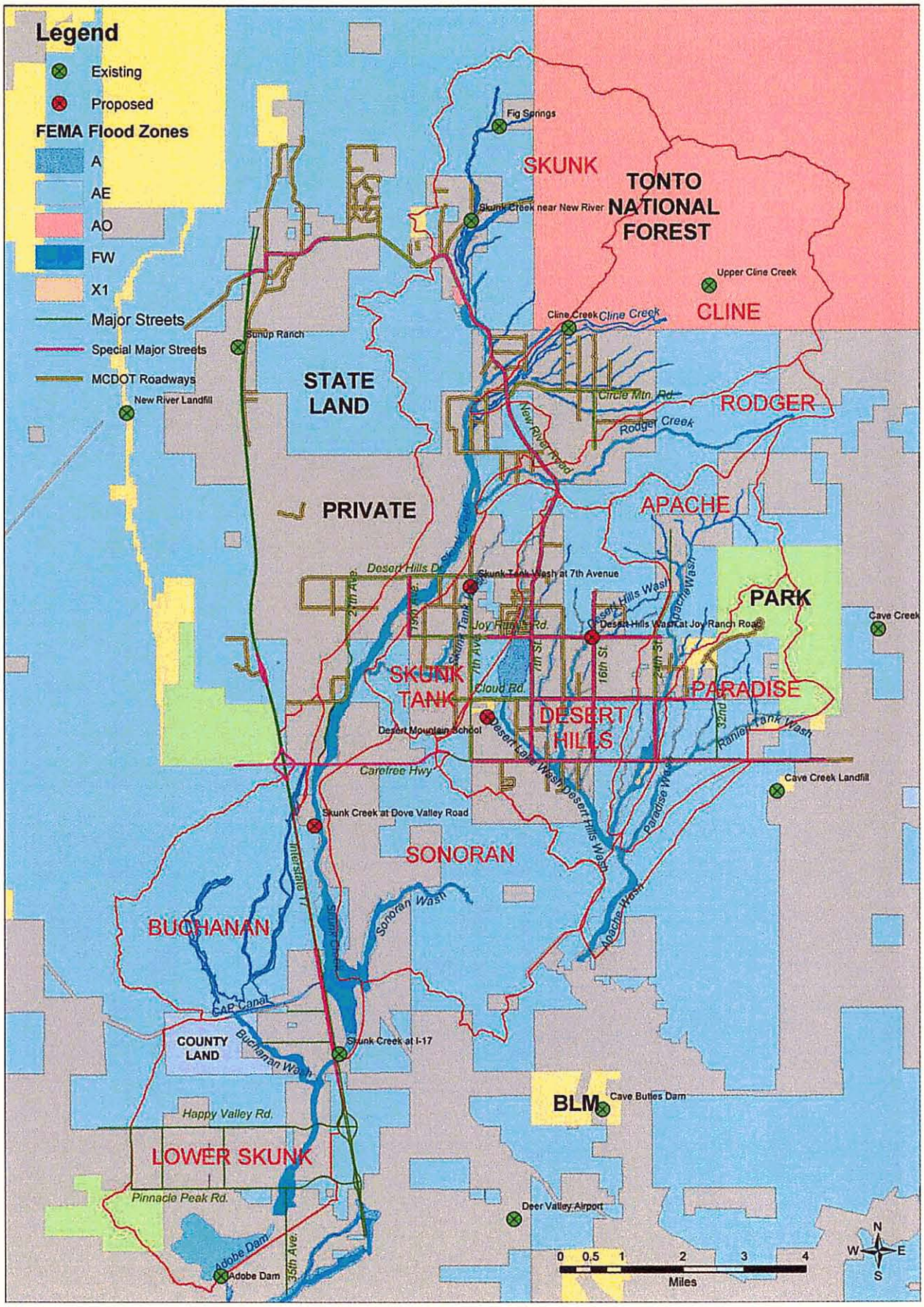


Figure 3-1. Flood Detection Network

Table 3-1. ALERT Stations in the Adobe Dam / Desert Hills Area

SENSOR NAME	SENSOR ID	DEVICE TYPE	DATE INSTALLED	T_R_S	LATITUDE	LONGITUDE	ELEVATION (FEET)
Skunk Tank Wash at 7th Ave		1 mm Tipping Bucket Rain Gage					
Desert Mountain School		1 mm Tipping Bucket Rain Gage					
Skunk Creek at Dove Valley Road		1 mm Tipping Bucket Rain Gage					
Desert Hills Wash at Joy Ranch Road		1 mm Tipping Bucket Rain Gage					
Cave Creek	4890	1 mm Tipping Bucket Rain Gage	05/29/03	6N-4E-29	33 49 48	111 58 04	1995
Cave Creek Landfill	4915	1 mm Tipping Bucket Rain Gage	04/22/93	5N-4E-07	33 47 33	111 59 47	1625
Cave Creek at Spur Cross	4920	1 mm Tipping Bucket Rain Gage	06/16/93	6N-4E-04	33 53 05	111 57 17	2280
Adobe Dam	5535	1 mm Tipping Bucket Rain Gage	10/25/82	4N-2E-21	33 40 37	112 09 12	1415
Upper Cline Creek	5545	1 mm Tipping Bucket Rain Gage	11/21/01	7N-3E-35	33 54 38	112 00 57	2520
Fig Springs	5555	1 mm Tipping Bucket Rain Gage	11/14/01	7N-3E-17	33 56 56	112 04 29	2380
Skunk Creek at I-17	5565	1 mm Tipping Bucket Rain Gage	11/08/89	5N-2E-35	33 43 47	112 07 21	1475
Cline Creek	5580	1 mm Tipping Bucket Rain Gage	08/01/81	7N-3E-33	33 54 03	112 03 19	2180
Skunk Creek near New River	5585	1 mm Tipping Bucket Rain Gage	06/28/01	7N-3E-30	33 55 35	112 04 59	2185
Sunup Ranch	5625	1 mm Tipping Bucket Rain Gage	06/01/81	6N-2E-03	33 52 53	112 09 00	2140
Adobe Dam Pool	5534	Bubbler/orifice line type	10/28/82	4N-2E-21	33 40 37	112 09 12	1413
Adobe Dam Outlet	5538	non-submersible PT connected to an orifice line					
Skunk Creek at I-17	5568	Pressure Transducer (PT)	10/26/89	5N-2E-35	33 43 47	112 07 21	1475
Skunk Creek at Dove Valley Road		Pressure Transducer					
Skunk Tank Wash at 7th Ave.		Pressure Transducer					
Skunk Creek near New River	5588	Pressure Transducer	11/20/01	7N-3E-33	33 54 03	112 03 19	2180
Cline Creek	5583	Pressure Transducer	06/21/95	7N-3E-30	33 55 35	112 04 59	2185
Desert Hills Wash at Joy Ranch Road		Pressure Transducer					
Desert Mountain School		Humidity					
Desert Mountain School		Temperature					
Desert Mountain School		Other Weather Sensor(s)					

3.2 Flood Detection Criteria

Based on the proposed completed flood detection network described in the preceding section, a series of flood detection criteria were established. These criteria vary for the two primary flood vulnerability groups: roadway drainage crossings and floodplain residences. Five color-coded flood alert levels were defined based on frequency of flood threat. The names and nature of the flood alerts for the Adobe FRP generally correlate to the color-coded alert levels in other District FRPs. The five color-coded zones and their meanings for the Adobe FRP are briefly described below.

Green Alert – The Green Alert level is used to designate that common to moderate flooding is imminent or occurring in the area. For the Adobe FRP, the Green Alert level is generally associated with storm events capable of generating some flooding up to about the 10-year flood. The primary impacts of flooding for a Green Alert are that numerous roadway drainage crossings become impassable for some (relatively short) period of time. Transportation to portions of the area may be difficult or impossible.

Orange Alert – The Orange Alert level is used to designate that moderate to significant flooding is imminent or occurring in the area. For the Adobe FRP, the Orange Alert level is generally associated with rainfall and/or flood events greater than the 10-year flood up to about the 50-year flood. It is above this Orange Alert level that homes within the floodplain begin to experience flooding in and around the buildings. In addition, numerous roadway drainage crossings will be impassable making transportation access around the area difficult to impossible for some (relatively short) period of time.

Red Alert – The Red Alert level is used to designate that significant to extreme flooding is imminent or occurring in the area. For the Adobe FRP, the Red Alert level is associated with floods greater than the 50-year flood. Flood hazards include closure of roadway drainage crossings and inundation of homes and other buildings within the floodplain. Transportation access throughout the area will be severely disrupted if only for a relatively short duration of time.

Blue Alert – The Blue Alert level is used to designate emergency conditions resulting from imminent or occurring flood water discharges from the emergency spillway of a dam, in this case, Adobe Dam. Flood hazards are located downstream of the emergency spillway of Adobe Dam. In addition, at Adobe Dam, the Blue Alert level would include inundation hazards upstream of the dam of structures located above the emergency spillway elevation, but below the top of the dam elevation. Large numbers of structures are threatened by flooding associated with a Blue Alert. Emergency response activities and responsibilities for emergency spillway discharge conditions at Adobe Dam are described in the Emergency Action Plan for Adobe Dam.

Purple Alert – The Purple Alert level is used to designate emergency conditions related to potential or actual dam failure, in this case of Adobe Dam. Emergency response activities and responsibilities for failure of Adobe Dam is outlined in the Emergency Action Plan for Adobe Dam. The affected areas are downstream of the dam embankment. Areas nearest to the dam will experience the most significant hazards. Potential hazards are considered life-threatening and very widespread.

The selection of detection criteria for each alert level is discussed in the following sections.

3.2.1 Roadway Drainage Crossings

For the evaluation of flood detection criteria for warning of impacts to roadway drainage crossings, it was assumed that the recurrence interval of rainfall is approximately equal to the recurrence interval of runoff. Given that most of the models used to generate runoff in the Adobe FRP study area were developed using rainfall-runoff models, this seems a reasonable assumption.

Table 3-2 shows the proposed flood detection criteria for roadway drainage crossings based on rainfall detection and their corresponding flood alert level.

Table 3-2. Proposed Flood Detection Criteria for Roadway Drainage Crossings

Recurrence Interval	Rainfall Depth	Flood Detection Criteria	Flood Alert Level
Most dip crossings & other nuisance drainage		0.5" / 30 min	Green
2-yr	0.9" / 30 min	1.0" / 30 min	Green
10-yr	1.3" / 30 min	1.4" / 30 min	Orange
50-yr	1.75" / 30 min	1.8" / 30 min	Red
100-yr	1.94" / 30 min	2.0" / 30 min	Red

For storms with longer durations it is recommended that criteria be taken from the depth-duration-frequency matrices for the area. This approach matches the results from the Skunk Creek FRP (Tetra Tech, 2001) recommendations as well. Table 3-3 shows the depth-duration-frequency statistics for the Desert Hills Area.

Table 3-3. Depth-Duration-Frequency Statistics for Desert Hills Area

	RAINFALL POINT VALUES, IN INCHES						
	RETURN PERIOD						
DURATION	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	500-YR
5-MIN	0.37	0.45	0.51	0.59	0.66	0.73	0.88
10-MIN	0.56	0.68	0.78	0.91	1.01	1.11	1.35
15-MIN	0.68	0.85	0.98	1.15	1.29	1.43	1.74
30-MIN	0.89	1.14	1.31	1.56	1.75	1.94	2.37
1-HR	1.09	1.41	1.63	1.94	2.18	2.42	2.97
2-HR	1.21	1.58	1.83	2.19	2.46	2.74	3.37
3-HR	1.29	1.69	1.97	2.35	2.65	2.95	3.64
6-HR	1.45	1.91	2.22	2.67	3.01	3.35	4.14
12-HR	1.63	2.17	2.55	3.07	3.47	3.88	4.80
24-HR	1.80	2.44	2.87	3.47	3.94	4.40	5.47

For back-to-back storms – i.e. saturated conditions – it is suggested that the 30-minute criteria could be reduced by 20% for a given frequency. This result is based on running HEC-1 models for the Desert Hills Area and Skunk Creek with IA and DTHETA = 0. These models are supplied on CD-ROM in the Appendix to this report.

As an alternate to the rainfall detection criteria, the streamflow pressure transducers should also be used to detect flooding conditions warranting roadway closures. Table 3-4 shows flood frequency estimates at the existing and proposed FCDMC ALERT stream gage locations. These flow rates could be set to detect runoff requiring closure of drainage crossings that become impassable below that level as shown in Table 2-1 (Recurrence Interval of Impassable Discharge at Roadway Drainage Crossings & Gage Assignments for Flood Detection). The color-coded flood alert levels correspond to the same event frequency as in Table 3-2 for the rainfall criteria.

Table 3-4. Flood Frequency Estimates for FCDMC ALERT Stream Gage Locations							
Water Level Gage	Q2 Green Alert	Q10 Orange Alert	Q50 Red Alert	Q100 Red Alert	D.A. (mi^2)	KK	Source
Skunk Tank Wash at 7th Ave	170	600	1250	1710	1.2	S17	SCE100.OH1 ratioed to 1.24 sq. mi. (vs. 1.03 original); ratios
Skunk Creek near Fig Springs	490	1720	3580	4900	4.3	S3C	SCE100.OH1; ratios
Skunk Creek at Dove Valley Road	970	6400	15900	27300	48.6	S22C	SCE100.OH1; JEF 17B FFF ratios of Skunk @ I-17 results shown below
Skunk Creek at I-17	1000	6650	16450	28200	64.3	S24C	SCE100.OH1; JEF 17B FFF for USGS gage data
Desert Hills Wash at Joy Ranch Road	130	450	940	1290	1.0	C109C	DH1006E.OUT; ratios
Cline Creek	1090	3810	7940	10880	10.7	CCO-2	SCE100.OH1 (10.62 sq. mi. original + 0.07); ratios

The rain gage and stream gage detection criteria were spatially assigned to each roadway crossing based on the estimate of the frequency of the flood that causes closure. Figure 3-2 shows the location of the flood vulnerable roadway drainage crossings and the rain gage Thiessen polygons. Figure 3-2 summarizes the spatial assignments of both rain gages and stream gages to each crossing location.

For roadway drainage crossings on Skunk Creek downstream of Cline Creek, multiple streamflow gages need to be considered to determine flood detection criteria to warn for closure of the road. Some of these analyses have been previously performed for the Skunk Creek FRP (Tetra Tech, 2001). With the addition of the Skunk Tank Wash gage some refinement of the previous criteria is warranted for crossings downstream of Skunk Tank Wash. Also, the Skunk Creek at Dove Valley Road gage can be used to provide detection for warning of overtopping of Interstate 17. Table 3-5 provides a summary of the roadway crossings along Skunk Creek and the suggested streamflow detection criteria for each location.

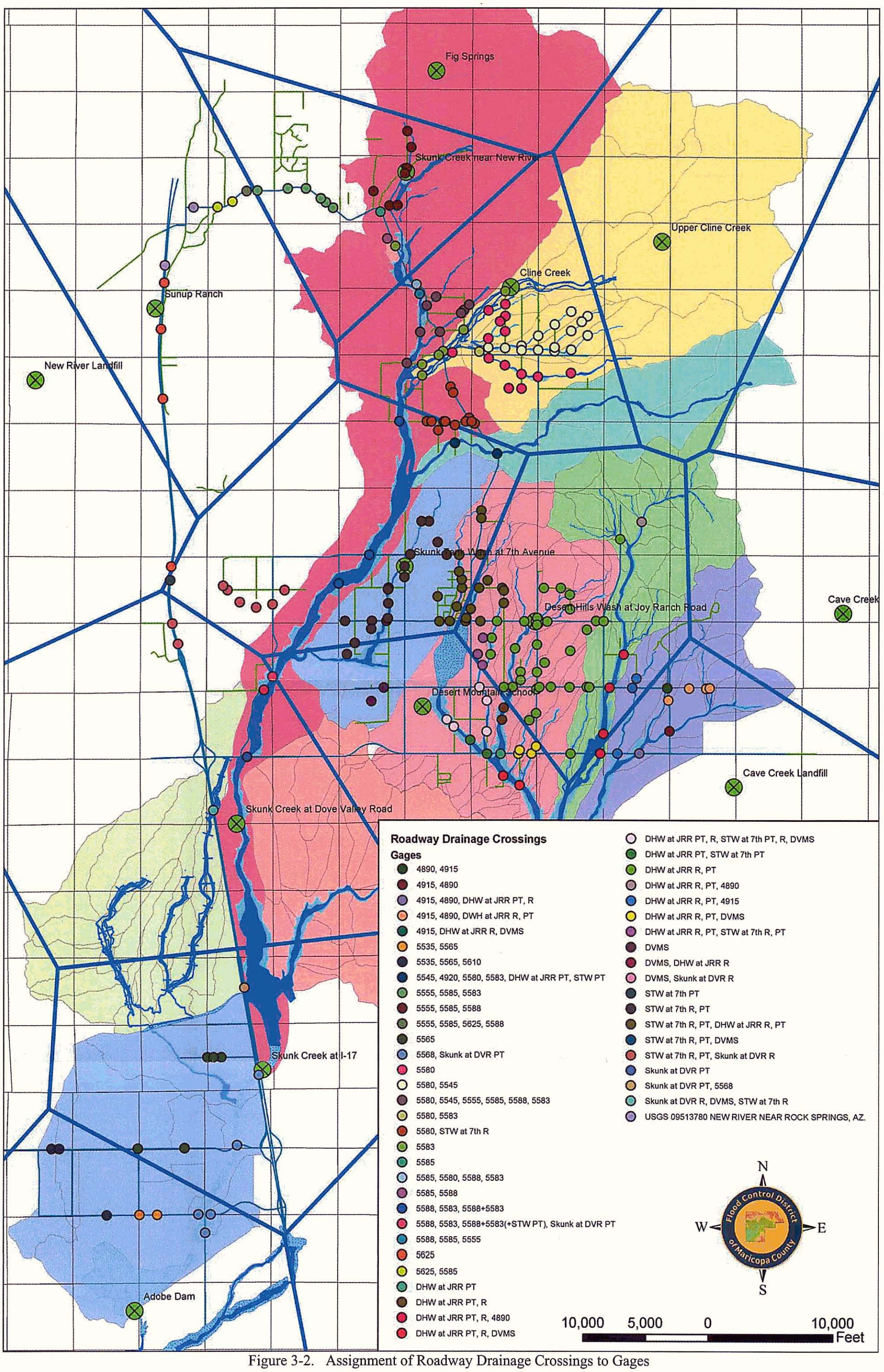


Figure 3-2. Assignment of Roadway Drainage Crossings to Gages

Table 3-5. Streamflow Detection Criteria for Roadway Closure Along Skunk Creek		
Location	Gage	Discharge[1]
Zorillo Road	5588	500 cfs
Shangri La Lane	5588	500 cfs
Circle Mountain Road	5588	500 cfs
Honda Bow Road	5588	500 cfs
Desert Hills Drive	5588 +/or 5583	500 cfs
19th Avenue	5588 +/or 5583	1,500 cfs
Cloud Road & 27th Ave.	Dove Valley Rd OR Combo of: STW, 5583 & 5588	10,000 cfs Approx. 10-year at each - 1660 cfs @ 5588 - 3250 cfs @ 5583 - 520 cfs @ STW
COP transfer station access road	Dove Valley Rd	5,000 cfs[2]
Interstate 17	Dove Valley Rd or 5568	16,000 cfs[3]
35th Ave & Pinnacle Peak Rd	5568	10,000 cfs[4]

[1] Detection discharges from Skunk Creek FRP (Tetra Tech, 2001)
[2] Detection discharges estimated from data in North Gateway North Transfer Station Access Road Technical Data Notebook (Tetra Tech, 2003)
[3] Approximated from FLO-2D (Tetra Tech, 2001) which showed overtopping at a discharge of about 17,600 cfs.
[4] Detection discharges computed as part of ADMP, Part 8, Vol. 2, Section 4

3.2.2 Residents in Floodplain

Homes located within the identified FEMA floodplains in the area were identified in the vulnerability analysis. Table 2-2 (Summary of Flood Vulnerable Residences – FFE vs. BFE) showed that many of these homes lie more than one foot above the base flood elevation. Although their homes may not be inundated by large floods, the data do not reflect the hazards presented to these residents due to inundation of their yard and access problems created around their house. In addition, a small percentage of these residences do experience inundation of their homes below the 10-year flood. Therefore, for the purposes of the FRP it is recommended that the 10-year flood be used as the threshold for detection and warning for floodplain residences. That is, floodplain residents will be warned upon detection of an Orange Alert whether at a rain gage or stream gage.

Given the clustered nature of the residences in the floodplain (see Figures 2-5 & 2-6), a number of warning areas were identified for flood warning notification. As discussed later, warning will be given via telephone using the Community Emergency Notification System (CENS). Predefined polygons can be used to select the most current phone numbers and make a phone call to the flood vulnerable residents at their home. Figure 3-4 shows the CENS areas and Figure 3-3 their gage assignments for flood detection. These data are also summarized in Table 3-6.

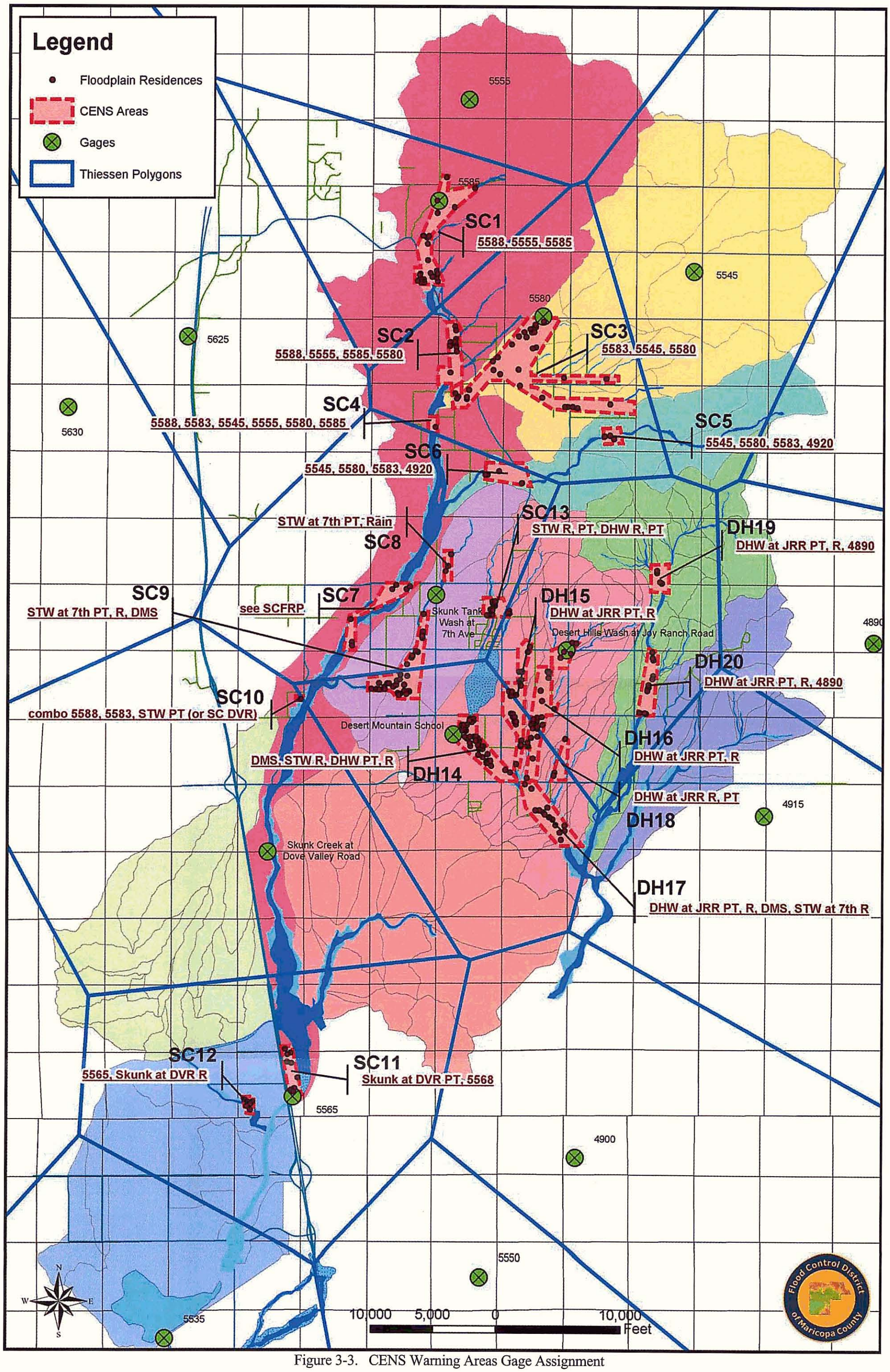


Figure 3-3. CENS Warning Areas Gage Assignment

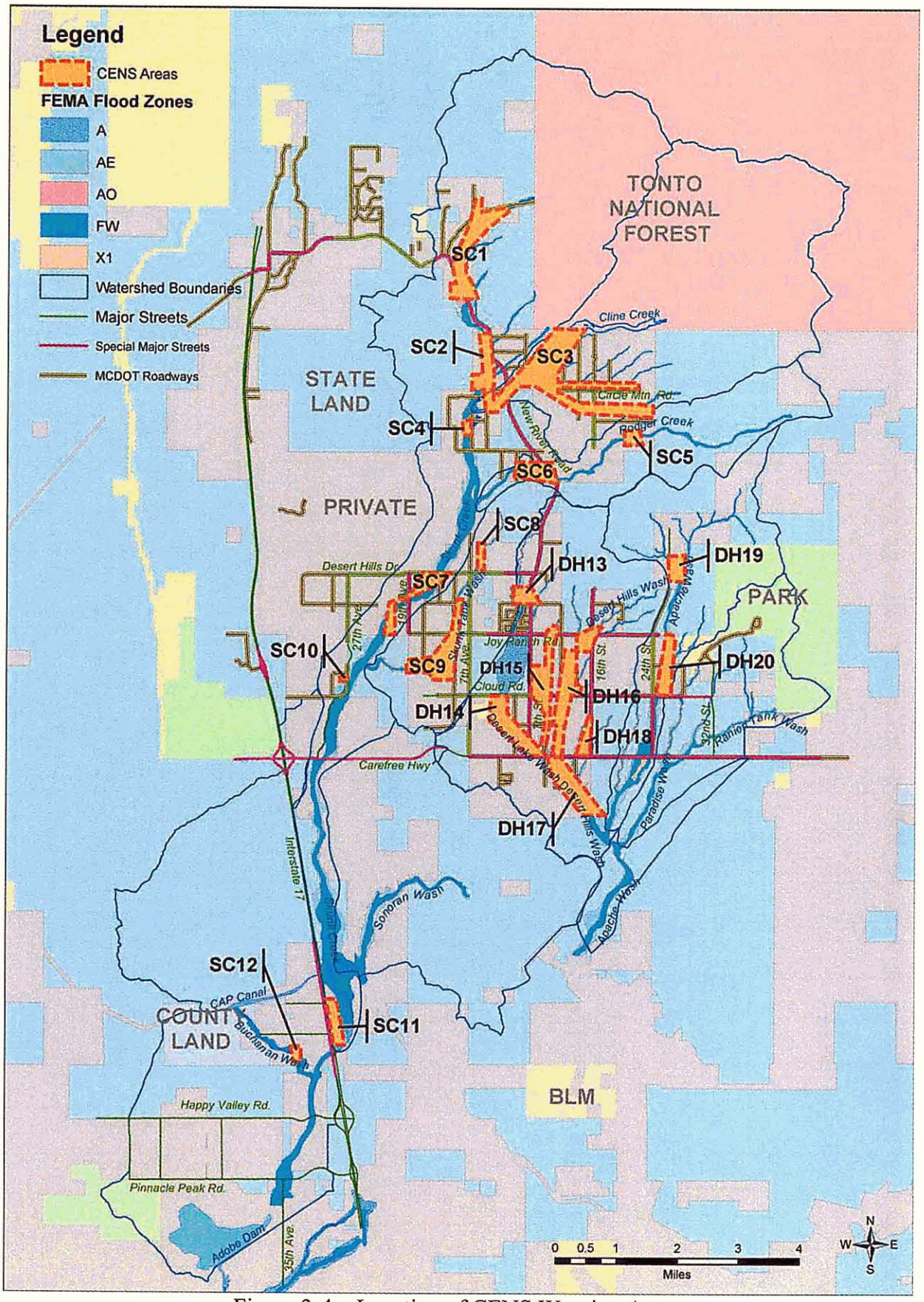


Figure 3-4. Location of CENS Warning Areas

Table 3-6. CENS Warning Areas and Gage Assignments			
CENS ID (used for message launch)	CENS Warning Area Descriptive Name	Wash Name	Gage(s) (R=Rain; PT=Water Level)
SC1	Upper Skunk Creek	Skunk Creek	5588, 5555, 5585
SC2	Skunk Creek just u/s of Cline	Skunk Creek	5588, 5555, 5585, 5580
SC3	Cline and tribs	Cline Creek & tribs	5583, 5545, 5580
SC4	Skunk Creek just d/s Cline	Skunk Creek	5588, 5583, 5545, 5555, 5580, 5585
SC5	Rodger near 20th St	Rodger Creek	5545, 5580, 5583, 4920
SC6	Rodger near New River Rd	Rodger Creek	5545, 5580, 5583, 4920
SC7	Skunk Creek near Desert Hills Dr	Skunk Creek	see Table 3-5
SC8	Upper Skunk Tank Wash	Skunk Tank Creek	STW at 7th PT, Rain
SC9	Skunk Tank Wash	Skunk Tank Creek	STW at 7th PT, R, DMS
SC10	Skunk Creek at 27th/Cloud	Skunk Creek	combo 5588, 5583, STW PT (or SC DVR)
SC11	Skunk near I-17	Skunk Creek	Skunk at DVR PT, 5568
SC12	Lower Buchanan Wash	Buchanan Wash	5565, Skunk at DVR R
DH13	Upper Desert Lake Wash	Desert Lake Wash	STW R, PT, DHW R, PT
DH14	Lower Desert Lake Wash	Desert Lake Wash	DMS, STW R, DHW PT, R
DH15	East Fork Desert Hills Wash	East Fork Desert Lake Wash	DHW at JRR PT, R
DH16	Upper Desert Hills Wash	Desert Hills Wash	DHW at JRR PT, R
DH17	Lower Desert Hills Wash	Desert Hills Wash	DHW at JRR PT, R, DMS, STW at 7th R
DH18	Desert Hills Trib near 16th	Desert Hills Wash Trib 2	DHW at JRR R, PT
DH19	Upper Apache Wash	Apache Wash	DHW at JRR PT, R, 4890
DH20	Middle Apache Wash	Apache Wash	DHW at JRR PT, R, 4890

Therefore, detection of a 10-year rainfall or streamflow event at one or more of the gages listed in Table 3-6 will trigger an Orange Alert for that CENS warning area. Section 4 provides the warning messages.

3.2.3 Critical At-Risk Facilities

Critical at-risk facilities in the FRP area include the CAP Canal and Interstate 17. Both of these facilities become potentially impacted above about 16,000 cfs on Skunk Creek. Detection of 16,000 cfs could be made at the new Skunk Creek at Dove Valley Road gage and/or the existing Skunk Creek at I-17 (#5568) stations. Previous two-dimensional modeling by Tetra Tech (2002) showed that above about 17,500 cfs floodwater does not pass gage #5568. Therefore, once significant flows are detected, on the ground observers will provide the best information about the need to close I-17 or take operational action on the CAP Canal.

3.2.4 Dam Emergencies – Blue and Purple Alerts

Although an emergency action plan for Adobe Dam is not a part of the scope of work for the Adobe FRP, potential flood emergency conditions at Adobe Dam are noted within this FRP. Adobe Dam was designed to safely impound and discharge floods up to the Standard Project Flood (SPF) (66,000 cfs) (USACE, 1982). Two-dimensional modeling by Tetra Tech (2002) suggests that the entire SPF flow may not be capable of reaching the flood pool with the current channel conditions upstream of Interstate 17. An updated Emergency Action Plan for Adobe Dam was completed in January 2005.

Blue Alert – Emergency Spillway Discharges

For floods in excess of the Standard Project Flood emergency spillway discharges are possible. In addition, homes located behind the dam above the emergency spillway elevation (1377.7 ft) are subject to inundation. The Probable Maximum Flood (PMF) at Adobe Dam has been estimated at 119,000 cfs with a maximum impoundment elevation of 1397.5 feet (NGVD 1929) in the flood pool (USACE, 1982).

Flood detection criteria for the Blue Alert are suggested based on examination of the Corps of Engineers' design storms for the SPF and PMF. Table 3-7 shows the rainfall detection criteria. As mentioned previously, above about 17,500 cfs the Tetra Tech 2-D analysis shows that not all flood water passes the 5568 gage. Therefore, direct streamflow detection of these events is somewhat complicated. Discharges in excess of the 100-year flood at Skunk Creek at Dove Valley could be used as a proxy for streamflow based detection criteria of SPF or PMF magnitude floods.

Table 3-7. Rainfall Flood Detection Criteria for Blue Alert for Adobe Dam	
SPF	PMF
5.72 inches / 7 hours	19.45 inches / 72 hours
3.2 inches / 75 minutes	4.73 inches / 75 minutes
2.8 inches / 60 minutes	4.3 inches / 60 minutes

Water level detection of Blue Alert would start at the latest when the reservoir pool reaches the emergency spillway elevation of 1377.7 feet (39.9 ft gage height). Given the potentially large number of affected individuals both upstream and downstream during such an event, it is recommended that Blue Alert be initiated at 90% of the reservoir storage (16,942.5 ac-ft which occurs at 38.45 ft gage height or about 1.5 feet below the spillway).

Purple Alert – Dam Failure

In addition to emergency spillway flows, potential dam failure is another dam emergency detailed in the Emergency Action Plan for Adobe Dam. For the FRP and EAP, dam failure (Purple Alert) detection was estimated based on examination of normal drawdown rates. Any rate of fall in excess of the normal draw down rate may indicate a potential dam failure. Figure 3-5 shows the draw down curve. Table 3-8 summarizes the potential detection criteria.

Table 3-8. Summary of Rate of Fall Alarms for Adobe Dam

Rate of Fall		Above (feet in gage height)
Feet	Hours	
1	3.0	42
1	6.6	30
1	4.7	22
1	3.1	16

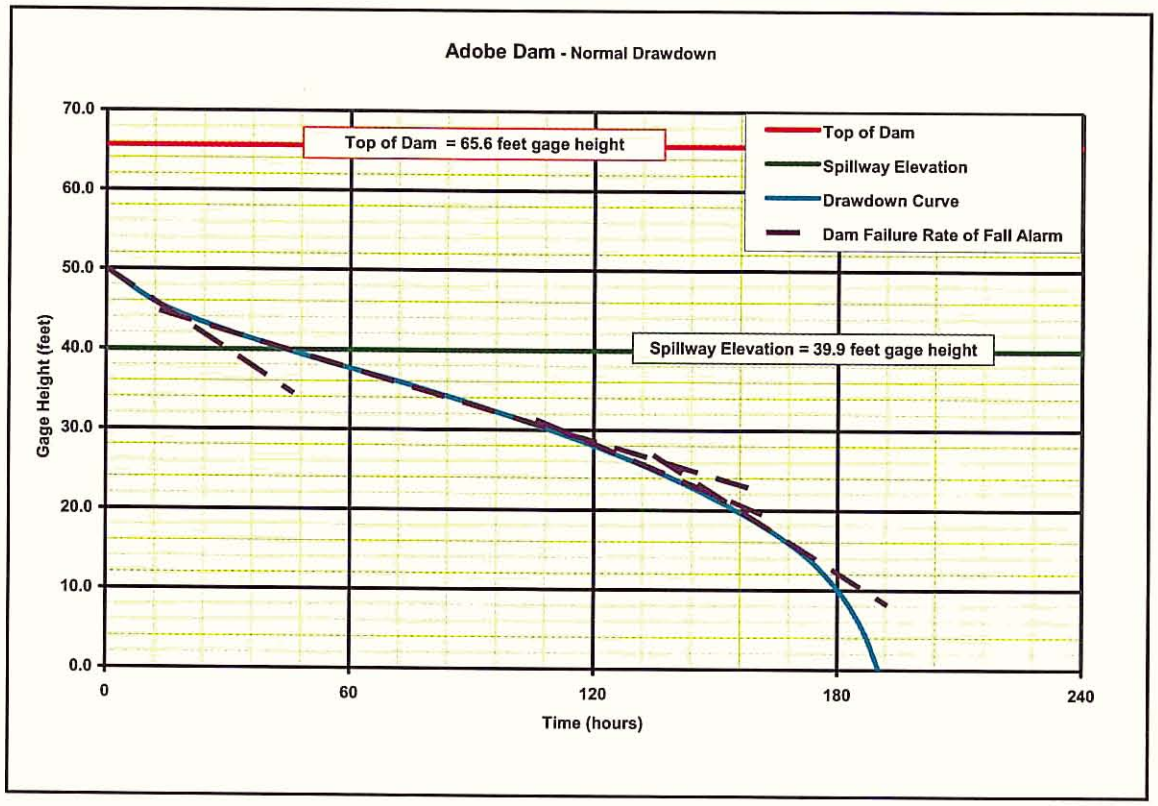


Figure 3-5. Adobe Dam Drawdown Curve

3.3 Summary and Important Considerations

Section 3 presents the methods and results of determination of flood detection criteria for the Flood Response Plan. For each of the flood alert levels (Green, Orange, Red, Blue, Purple), the detection criteria are identified and the methods of their derivation described. The flood detection criteria rely on incorporation of the suggested enhancements to the FCDMC ALERT detection network.

Ideally, a flood threat could be identified by prediction based on a meteorological forecast and some modeling or historical results to compare against the forecast. A prediction-based flood response plan would allow the maximum amount of time possible for reaction and response by emergency personnel. Unfortunately, predictions are frequently quite divergent from reality. Therefore, flood response activity often waits for confirmation of a forecast through direct observation of heavy rainfall or runoff either by people or instruments. Reaction and response based on measured rainfall allows the second greatest amount of time to perform response activity. However, the same rainfall observed or the nature of the observation (i.e. rain gage) also includes a certain degree of uncertainty in the precise amount of runoff that will result. Therefore, the type of detection that lends the highest degree of certainty is observation or measurement of runoff. However, waiting to observe or measure the runoff leaves response personnel the least time to react.

Given the trade-offs of response time and uncertainty, it is recommended that the primary detection method for flood response for the FRP is measurement or observation of runoff. The secondary detection method recommended is measurement of rainfall. Forecasts of heavy rainfall are recommended for use as a "heads up" providing valuable information for emergency response personnel to be prepared for possible action or reaction to a flood.

3.4 Flood Prediction Capability

3.4.1 District Meteorological Services Program

The Flood Control District of Maricopa County operates a program known as the Meteorological Services Program (or MSP) to provide "timely and accurate weather information regarding the potential for flood producing rain and/or damaging wind." (FCDMC, MSP SOP, 7/31/02). Weather Outlooks are issued daily describing the outlook for flood producing precipitation for 15 zones within the County. The Adobe Dam / Desert Hills area is located within the New River / Cave Creek MSP Zone. In addition to the daily Weather Outlook, a suite of flash flood advisory

messages are generated when the potential for flood producing rainfall is forecast. Times and depths of forecasted rainfall are provided. These messages can serve as a basis for advance preparations prior to rain hitting the ground.

The following description of the message suite as shown in italics is taken directly from the MSP Standard Operation Procedure:

Weather Outlook: *The daily outlook will be disseminated to all clients Monday through Friday (daily during the monsoon season), between 1:00PM and 1:30PM. In addition, from about October 1 to July 1, a preliminary Outlook is issued around 8:00AM Monday through Friday. Outlooks include a synopsis of expected weather conditions for the remainder of the day, the coming night and following morning; the expected hours the bulk of the rain will fall (prime time); the probability of rain during "prime time"; and the amount of rain expected during this period. Also. time and space permitting, the afternoon Outlook will include expected weather trends for the following 2 or 3 days. Expected wind conditions will also normally be included in the synopsis portion of the Outlook.*

Message 1 - Alert: *When it is believed developing weather conditions may lead to flooding and/or destructive winds an Alert will be issued. Lead time will generally be 1 to 3 hours in advance of the expected event. The Alert will normally include the zones to be affected, the time frame of the expected event, and the type of areas that will impacted - such as roads, washes, or streams.*

Message 2 - Flash Flood Watch: *When it appears the developing weather event may lead to flash flooding a Watch will be issued for the expected affected areas. Lead time will generally be 1 to 2 hours in advance of the expected event. The Watch will include the time frame it will be in effect (valid time).*

Message 3 - Flash Flood Warning: *When it appears flash flooding is imminent a Warning will be issued for the expected affected areas. Lead time will generally be less than an hour. The Warning will include the time frame it will be in effect (valid time).*

Message 1, 2 & 3 Update: *This message will update the existing Alert, Watch or Warning.*

Message 4 - Cancel: *When an event is no longer poses a threat to the areas mentioned in a Watch or Warning a Cancel message will be issued.*

Track Forecast: *At times the depiction of expected thunderstorm movement may best be shown by a graphic, including location of the primary thunderstorms of concern, and a 1-hour forecast track of these storms.*

Quantitative Precipitation Forecast (QPF): *This graphical product may be issued when the forecaster believes he has a good grasp as to how much rain will fall where, and when (valid time).*

The MSP is operated independently of the National Weather Service which issues its own advisory statements regarding severe weather and flood producing rainfall and as described below in Section 3.4.2.

3.4.2 National Weather Service Products

In addition to the MSP products, the National Weather Service (NWS) also issues messages of flash flood and severe weather watches and warnings. The NWS also issues an urban small stream advisory to warn the public and public officials of the likelihood of runoff in small urban area streams.

The following is a brief synopsis of the NWS message suite:

Severe Thunderstorm Warning: A Severe Thunderstorm Warning is issued when the NWS determines that a severe weather occurrence is imminent or already occurring. Severe weather includes tornadoes, high wind, dust storms, hail, or locally heavy rainfall.

Flash Flood Watch: A Flash Flood Watch is issued when the NWS determines that a threat exists for flash flooding due to meteorological and soil conditions. The NWS Watches are typically issued for an entire County or a large portion of a County. The time period for Flash Flood Watches is typically from 3 to 12 hours or longer.

Urban Small Stream Advisory: An Urban Small Stream Advisory is issued by the NWS when locally heavy rainfall is expected to occur but the total rainfall is expected to be less than the criteria for a Flash Flood Warning. Usually the type of flooding that is expected to result is of a nuisance variety and expected to pose a minimal threat to life and property.

Flash Flood Warning: A Flash Flood Warning is issued by the NWS when flash flooding is imminent or already occurring. A flash flood warning is often issued for specific basins over a period of 1 to 6 hours. Flash Flood Warnings are often issued based on

observed flooding either by ground observers or telemetered stream gages. Additionally, Flash Flood Warnings may be issued on the basis of rain gages or radar.

The means for dissemination of the NWS and MSP flood warning messages are described in Section 4.1. The response to each type of message from either the MSP or the NWS is described in Section 6.1.

3.5 Summary

Table 3-9 shows a summary of the Flood Detection Criteria recommended for implementation for the FRP. The criteria were established by a combination of hydrologic and hydraulic modeling and application of engineering judgment.

Table 3-9. Summary of Flood Detection Criteria

Flood Alert	Description of Flood Vulnerable Areas	Rainfall Detection Criteria	Water Level Detection Criteria
Green	At-grade and small culvert roadway drainage crossings	0.5" / 30 min.	
Green		1.0" / 30 min.	2-year flow See Table 3-4
Orange	Additional roadway drainage crossings and floodplain residences	1.4" / 30 min	10-year flow See Table 3-4
Red	Additional roadway drainage crossings and floodplain residences	1.8" / 30 min.	50-year flow See Table 3-4
Blue	Areas downstream of emergency spillway and above emergency spillway crest elevation within the flood pool area of Adobe Dam	2.8" / 60 min.	1) Observer 2) 38.5 ft gage height
Purple	Areas downstream of Adobe Dam embankment	N/A	1) Observer 2) Rate of Fall See Table3-8
Special Skunk Creek Roadways	Roadway drainage crossings of Skunk Creek	N/A	See Table 3-5

Note: Flood vulnerable roadway drainage crossings shown on Figure 2-4 and large maps in Appendix.
Flood vulnerable residences shown on Figure 3-4 and large maps in Appendix.

SECTION 4: INFORMATION DISSEMINATION

There are two primary groups who will require dissemination of information amongst themselves. The first group is the agencies. This group includes the FCD, NWS, MCDOT, MCDEM, MCSO, MC Parks, DMFD, COP, DPS, ADOT, CAP, and the Town of Cave Creek. The second group is the public. The general public will be especially subject to hazards at roadway drainage crossings. Residents in the floodplain represent a special portion of the public to whom communication of impending flooding will be especially important. Finally, visitors to the Cave Creek Regional Park may require some contact regarding impending or occurring flooding.

In the first group (agencies), remotely sensed data (radar or ALERT) comes into the FCD and the NWS. They utilize/interpret these data based, in part, on the flood detection criteria described in Section 3. If threatening conditions are expected or detected, they notify the other agencies and/or the public. NWS can alert the general public via NOAA Weather Radio and the Emergency Alert System (EAS). The FCD alerts sister County agencies who either respond directly or use their own internal mechanisms to contact additional effected parties. MCDEM serves as the primary disseminator of emergency information for the County. Park visitors will be alerted by Maricopa County Parks personnel.

The Community Emergency Notification System (CENS) will be used to contact floodplain residences. The Flood Warning Branch of the FCD will initiate the CENS message calls for the affected CENS group(s).

The message suite for the Adobe FRP is comprised of flood warning messages issued by the National Weather Service (NWS), Flood Control District of Maricopa County (FCDMC) Meteorological Services Program (MSP), and the Community Emergency Notification System (CENS). The message suite is summarized in Section 5. Each of these three groups of messages will be disseminated to emergency response agencies using multiple means of communication as described in this section. Notification via multiple paths is provided for redundancy and robustness of the flood warning system. See Section 4.5 for a discussion and flowchart of communication paths. The issuance of any of the warning messages will trigger emergency response per the action plans described in Section 6.

4.1 Dissemination of NWS and FCDMC Messages

The earliest recognition of a potential flood threat for the watersheds affecting the Adobe FRP area will be the forecast products available from the NWS and FCDMC.

4.2 National Weather Service Products

Section 3.4.2 describes the NWS flood warning products. The NWS issues Flash Flood Watch and Flash Flood Warning messages on a county-wide basis. The NWS will issue warning messages to emergency response agencies and the public via:

- *Emergency Alert System (EAS)* – The system consists of radio and television broadcast stations in the Phoenix operational area that are responsible for disseminating emergency information and warnings to the public. EAS broadcasts by commercial media are voluntary, but experience shows that the stations regularly transmit NWS messages.

- *NOAA Weather Radio (NWR)* – NWS issues Flash Flood Watch and Flash Flood Warning messages via NOAA Weather Radio according to standard protocol using tone alarms followed by voice messages.

- *Arizona Criminal Justice Information System (ACJIS)* – The ACJIS relays NWS warning messages issued for any portion of Arizona to law enforcement agencies via teletype. The ACJIS does not provide this service to the general public.

- *Internet* – Emergency response agencies and the public can proactively access NWS forecast products and warning messages directly on the Internet. Several weather related web sites are available. A recommended site is 24-hour hydrologic and weather information for the entire state available at http://newweb.wrh.noaa.gov/psr. A link to this site is also provided on the FCD ALERT web page under the links section.

4.3 FCDMC Meteorological Services Program (MSP) Messages

Section 3.4.1 describes the MSP flood warning products. The goal of the MSP is to reduce the response time of emergency managers by providing timely and accurate weather information regarding the potential for flood producing rain and/or damaging winds. FCDMC MSP messages are coordinated with the NWS Weather Forecast Office at Phoenix; however, MSP forecasts and messages are relatively more site-specific to the watersheds impacting the Adobe FRP area. Thus, the MSP products serve to supplement the NWS forecast and warning products.

FCDMC MSP products are disseminated via broadcast fax and/or e-mail to participant agencies. The District may also notify by telephone to aid in decision making. The District does not disseminate MSP messages directly to the public. Similar to the NWS warning messages, the response agencies and general public may proactively access weather and ALERT information via the Internet at http://www.fcd.maricopa.gov/Services/ALERT/default.asp or access the MSP Daily Outlook directly at http://www.fcd.maricopa.gov/Services/ALERT/Outlook.asp.

The existing predictive tools, such as the NWS and MSP forecast products, should be utilized to raise agencies' awareness that the issuance of flood alerts and the implementation of emergency action plans may become necessary.

4.4 Dissemination of Flood Alert Messages

The largely negative effective lead times directly influence the options available for dissemination of Flood Alert messages to both responding agencies and to the public. First, a highly reliable and efficient means of communicating flood warning messages to the emergency response agencies is necessary to minimize the time required to implement the agency action plans. Second, a mechanism is needed for warning residents of impending and/or occurring flood events.

4.4.1 Agency Dissemination

Section 2.1 describes the Flood Alert levels. The FCDMC ALERT sensors will be programmed to alarm first when critical rainfall and water level thresholds are reached. The Flood Warning Branch will issue Flood Alert warnings to emergency responders based on the flood detection criteria described in Section 3.2. Communications will be primarily by telephone using the agency contact

list (Table 4-2) with 2-way radio back-up according to the communications flowchart for County agencies (Figure 4-1).

The Flood Warning Branch will have primary responsibility for issuing Green, Orange, and Red Alerts and communicating those messages to the emergency response agencies as described above. In the case of the Orange Alert, the Flood Warning Branch is also responsible for contacting residents in the CENS warning areas directly by requesting activation of a CENS message call through the Maricopa County Sheriff's Office (MCSO) Communications Shift Supervisor.

CENS is a telephone-based emergency notification system that utilizes reverse 911 capabilities to quickly disseminate recorded voice messages advising call groups of emergency conditions and recommended emergency response actions.

The collection and maintenance of current resident contact information will be handled by the CENS system database. When gage data and/or observers indicate impending emergency spillway flows at the dams, the FCDMC Flood Warning Branch will provide technical support to MCDEM for decisions involving the issuance of Blue or Purple Alerts. Reference should also be made to the Emergency Action Plan for Adobe Dam in the event of flooding on Skunk Creek.

Table 4-1 gives the CENS warning area IDs, descriptive names, and wash names needed to include in a CENS message. Briefly, to launch a CENS message to one or more warning areas, the Flood Warning Branch will contact the MCSO Communications Shift Supervisor and request a CENS message launch. The Flood Warning Branch personnel will need to provide the Communications Shift Supervisor with the CENS warning area ID(s) (e.g. SC3) and the message to be launched. An example message script is provided in the Appendix. A detailed procedure list to activate a CENS message launch is also provided in the Appendix. The purpose of providing the detailed procedure list separately is to provide a stand alone product that can be copied, laminated, etc. for use by Flood Warning Branch personnel at the FCDMC or at home.

Agencies and the public can also monitor the ALERT system via the internet.

Table 4-1. CENS Warning Areas		
CENS ID (used for message launch)	CENS Warning Area Descriptive Name	Wash Name
SC1	Upper Skunk Creek	Skunk Creek
SC2	Skunk Creek just u/s of Cline	Skunk Creek
SC3	Cline and tribs	Cline Creek & tribs
SC4	Skunk Creek just d/s Cline	Skunk Creek
SC5	Rodger near 20th St	Rodger Creek
SC6	Rodger near New River Rd	Rodger Creek
SC7	Skunk Creek near Desert Hills Dr	Skunk Creek
SC8	Upper Skunk Tank Wash	Skunk Tank Creek
SC9	Skunk Tank Wash	Skunk Tank Creek
SC10	Skunk Creek at 27th/Cloud	Skunk Creek
SC11	Skunk near I-17	Skunk Creek
SC12	Lower Buchanan Wash	Buchanan Wash
DH13	Upper Desert Lake Wash	Desert Lake Wash
DH14	Lower Desert Lake Wash	Desert Lake Wash
DH15	East Fork Desert Hills Wash	East Fork Desert Lake Wash
DH16	Upper Desert Hills Wash	Desert Hills Wash
DH17	Lower Desert Hills Wash	Desert Hills Wash
DH18	Desert Hills Trib near 16th	Desert Hills Wash Trib 2
DH19	Upper Apache Wash	Apache Wash
DH20	Middle Apache Wash	Apache Wash

Table 4-2. Emergency Contact Information

PRIMARY RESPONDERS		
AGENCY	CONTACT	TELEPHONE NUMBER
EMERGENCY DIAL 911		
National Weather Service (NWS)	*24/7 Forecaster *Meteorological Information for Emergency Responders only*	602-275-7003
Flood Control District of Maricopa County (FCDMC)	*Flood Warning Branch ALERT Room	602-506-8701 or 602-272-0132
Maricopa County Department of Emergency Management (MCDEM)	*Duty Officer	602-273-1411
Maricopa County Department of Transportation (MCDOT)	*Barricade Crew	602-506-6063
Maricopa County Sheriff's Office (MCSO)	*Duty Officer Communication Services	602-256-1011
Maricopa County Parks Department (MC Parks)	*Natalie Olson, *Cave Creek Regional Park Supervisor*	623-465-0431 602-201-7440 pager
MCSO CENS Activation	*1. Communications Shift Supervisor 2. Communications Shift Supervisor, 911 Center Emergency Cell 3. County Radio 4. Communications Division Commander Cell	602-876-1030 602-525-0218 "61 Sheriff" 602-525-1872
Daisy Mountain Fire Department (DMFD)	*Battalion Chief	623-465-7400 or 602-495-5555
City of Phoenix	Streets Maintenance Dispatch City Operator (24-hours)	602-262-6441 602-262-6200
Deer Valley Unified School District (DVUSD)	*Nick Portonova, *Director, Transportation* Dr. Kent Davis, *Assoc. Superitendant*	602-467-5091 office 623-512-0926 cell 623-445-4951
SECONDARY RESPONDERS		
Central Arizona Project (CAP)	Control Center	623-869-2562
Arizona Department of Transportation (ADOT)	Highway Division – District 1 Engineer	602-255-7381
Arizona Department of Public Safety (DPS)	Switchboard	602-223-2000
Floodplain Residents	*CENS	CENS

* Primary contact

The primary contact in each agency is responsible for disseminating the information within their agency.

The stakeholder agencies were divided into two groups: the primary or initial responders in the emergency action sequence, and the secondary responders.

The FCDMC Flood Warning Branch will generally contact MCDEM who will contact other affected parties. One important exception are the floodplain residents. The Flood Warning Branch will initiate contact with the effected floodplain residents via the CENS system through the MCSO Communications Shift Supervisor.

4.4.2 Public Dissemination

The Green Alert level primarily affects at-grade and small undersized roadway drainage crossings. Therefore, the primary on-site emergency task involves roadway closures. Barricades placed at overtopped crossings communicate to residents that roadway passability is unsafe. MCDOT will be responsible for placement of barricades in the unincorporated County. The City of Phoenix Streets Maintenance will be responsible for placement of barricades in Phoenix. The City of Glendale Traffic Operation Division will be responsible for barricading dip crossings of Skunk Creek downstream of Adobe Dam per the EAP for Adobe Dam. Other means of communicating the passability status of roadway crossings include some type of staff gage at road crossings that provide motorists with a physical demonstration of the depth of flow and associated hazard. General "Do Not Cross When Flooded" signs are also better than nothing.

At the Orange Alert level, the Flood Warning Branch will initiate a CENS notification through the MCSO Communications Shift Supervisor to CENS groups affected by the flood event. Affected groups include additional roadway drainage crossings and floodplain residents. Agencies will be notified by telephone and/or radio. Floodplain residences will be contacted by CENS via telephone. MCDEM will also be notified that a CENS notification has taken place. An example CENS message script is provided in the Appendix.

At the Red Alert level, additional roadway drainage crossings, including on major thoroughfares, become impassable and hazards to floodplain residences increase. MCDEM will be responsible for

calling the agency primary contacts similar to the Green Alert level. In addition, monitoring of potential closure of Interstate 17 should be requested. The Flood Warning Branch will initiate a CENS notification to affected floodplain residences if the Orange Alert level is bypassed due to rapidly developing conditions.

At the Blue and Purple Alert levels, MCDEM will be the primary agent of information dissemination. Reference to the Adobe Dam Emergency Action Plan should be made.

A public information program is recommended to educate floodplain and other area residents about the flood hazards in their community. An example letter that could be sent to floodplain residents within the CENS notification areas prior to each flood season is provided in the Appendix. Candidate elements of a public education program include public meetings, web pages, newspaper articles, brochures, mailers in utility bills, and/or an annual Flood Awareness Week just prior to the summer monsoon season. NWS and FCDMC have printed materials available that could be used directly or adapted to the specific needs of the FRP. It is strongly recommended that particularly residents living in floodplain areas are contacted in advance of flood season and receive materials about the FRP, CENS, flooding hazards, and emergency response procedures.

4.5 Communications Flowchart

The flow of information and communications in the FRP among personnel within the participating agencies will be as described above, shown in Figure 4-1, and by normal methods now in operation. The Flood Warning Branch and MCDEM will be the central contacts for communications concerning the FRP. Figure 4-1 is a visual representation of the communication paths between the sources of flood information and the end users of that information.

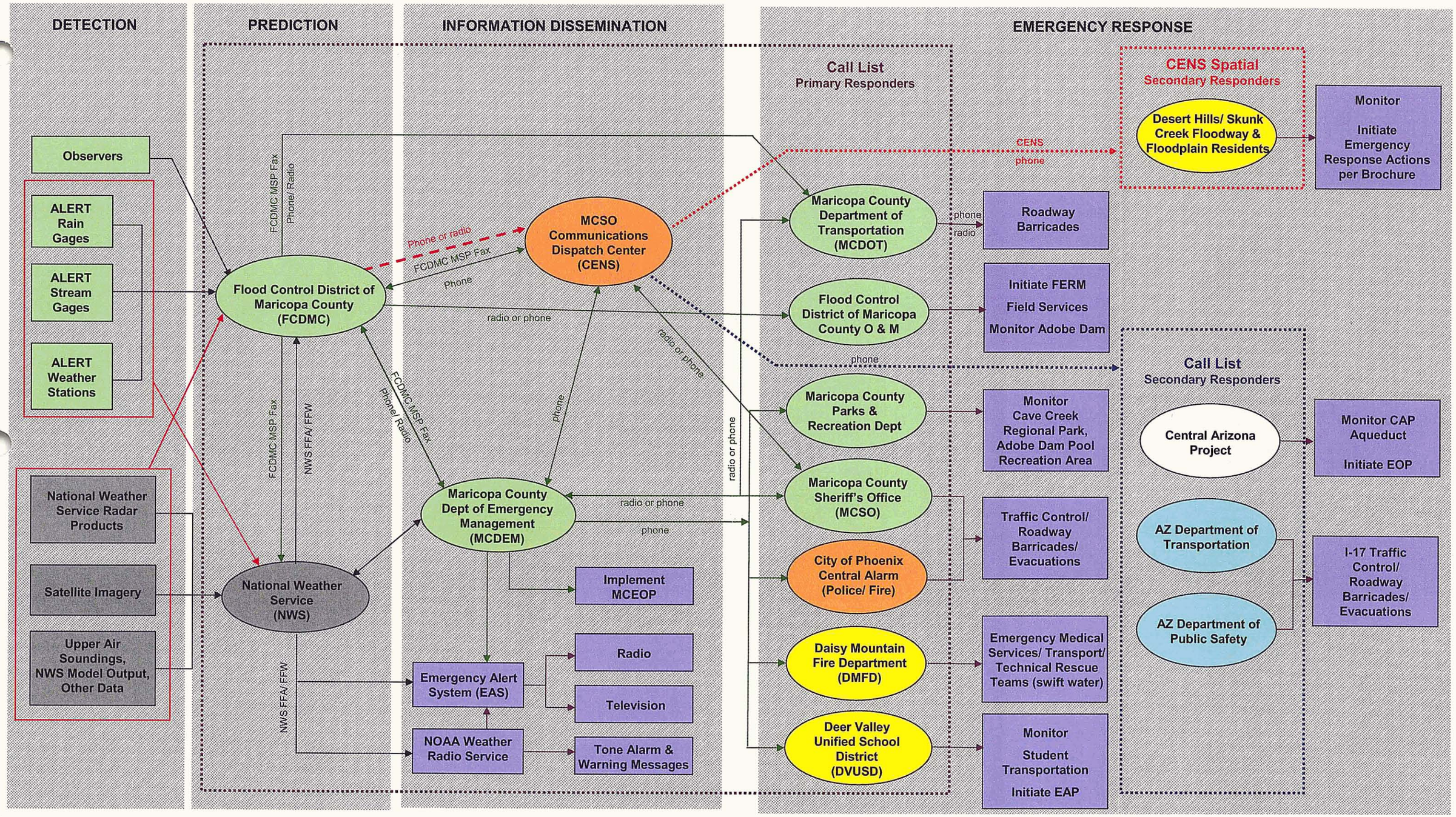


FIGURE 4-1. ADOBE DAM / DESERT HILLS FLOOD RESPONSE PLAN

COMMUNICATIONS FLOWCHART

SECTION 5: FLOOD WARNING MESSAGE SUITE

Table 5-1 presents the message sequence, source agency, message content, and corresponding flood condition status for the NWS and FCDMC MSP flood warning message suite. Table 5-2 presents the same set of information for the Adobe FRP Flood Alert message suite. The flood detection criteria described in Section 3.3 trigger the progression of the Flood Alert message sequence to increasing **or** decreasing levels of alert as evolving flood conditions warrant. Similarly, note that flood alert messages may **not** always sequentially follow the levels presented in Tables 5-1 and 5-2. For example, it is possible for a flood emergency to progress directly to an Orange Alert without a Green Alert being issued due to rapidly developing adverse weather conditions.

The emergency action plans of the Adobe FRP for stakeholder agencies are described in Section 6.1. The implementation of those action plans is linked directly to the dissemination of the various flood alert messages as triggered by the flood detection criteria.

An example of a CENS message script is provided in the Appendix.

Table 5-1. Adobe FRP Flood Warning Message Suite - NWS And FCDMC Warning Messages

MESSAGE SEQUENCE	MESSAGE CONTENT	FLOOD CONDITION STATUS
NATIONAL WEATHER SERVICE (NWS) Via NOAA Weather Radio Service, Emergency Alert System (Commercial Radio & TV), Arizona Criminal Justice Information System (ACJIS) and Internet at http://www.phx.noaa.gov		
SEVERE THUNDERSTORM WARNING	National Weather Service **Severe Thunderstorm Warning** (begin time/ end time)	• *A severe weather occurrence is imminent or already occurring.* • Severe weather includes tornadoes, high wind, dust storms, hail, or locally heavy rainfall.
FLASH FLOOD WATCH (FFA)	National Weather Service **Flash Flood Watch** (begin time/ end time)	• Threat exists for flash flooding due to meteorological and soil conditions. • Typically issued for entire Maricopa County or a large portion of the County. • Time period typically 3 to 12 hours or longer.
URBAN SMALL STREAM FLOOD ADVISORY	National Weather Service **Urban Small Stream Flood Advisory** (begin time/ end time)	• Locally heavy rainfall is expected to occur, but total rainfall is expected to be less than the criteria for a Flash Flood Warning. • Usually nuisance flooding is expected to result and poses minimal threat to life and property.
FLASH FLOOD WARNING (FFW)	National Weather Service **Flash Flood Warning** (begin time/ end time)	• Flash flooding is imminent or already occurring. • Often issued for specific basins over a period of 1 to 6 hours. • Often issued based on ground observers or telemetered stream gage data. • Flash Flood Warnings may be issued on basis of rain gage or radar data.
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY (FCDMC) **METEOROLOGICAL SERVICES PROGRAM (MSP)** Via Broadcast Fax and e-mail		
WEATHER OUTLOOK	Synopsis of expected weather conditions; Percent chance of rain; Prime time for rain; Maximum prime time rainfall amount.	• Disseminated daily between 1:00PM and 1:30PM
MESSAGE 1 ALERT	Affected zones; Time frame of expected event; Types of impacted areas (i.e., roads, washes/ streams).	• Developing weather conditions may lead to flooding and/or destructive winds. • Lead time generally 1 to 3 hours in advance of expected event.
TRACK FORECAST	Graphic showing location of primary thunderstorm; forecast storm track	• Depiction of expected thunderstorm movement. • Time frame generally for the next 1 or 2 hours.
MESSAGE 2 FLASH FLOOD WATCH	Affected zones; effective times; explanatory comments.	• Developing weather event may lead to flash flooding. • Lead time generally 1 to 2 hours in advance of expected event.
QUANTITATIVE PRECIPITATION FORECAST (QPF)	Graphic showing forecast rainfall amounts and locations	• Depiction of expected rainfall amounts and locations.
MESSAGE 3 FLASH FLOOD WARNING	Affected zones; effective times; explanatory comments.	• Flash flooding appears imminent for the expected affected areas. • Lead time generally less than 1 hour.
MESSAGE 2 & 3 UPDATE	Explanatory comments	• Updates existing Watch or Warning.
MESSAGE 4 CANCEL	Explanatory comments	• Event no longer poses a threat to areas mentioned in Watch or Warning.

Table 5-2. Adobe FRP Flood Warning Message Suite

MESSAGE SEQUENCE	MESSAGE CONTENT	FLOOD CONDITION STATUS
FCD FLOOD WARNING BRANCH Via Telephone or 2-way Radio		
GREEN ALERT	**Green Alert** **Wash Name(s)** (begin time/ end time)	• *Frequent storm, nuisance flood event.* • Potential for loss of life exists at roadway crossings. • *Criteria*: Rainfall Rate as follows and/or Critical Flow Rates at stream gages (Tables 3-2, 3-4, & 3-5) - Green 0.5" / 30 minutes - Green 1.0" / 30 minutes - 2-year flow rates -Washes overtop Green roadway crossings at depth of 6" or more. • Roadway closures required at impassable Green crossings. • No structures are threatened. • No evacuations required. • Some areas may be inaccessible
ORANGE ALERT	**Orange Alert** **Wash Name(s)** **CENS Group(s)** (begin time/ end time)	• Approximate 10-year flood event. • Potential for inundation of some floodplain residences. • *Criteria*: Rainfall Rate as follows and/or Critical Flow Rates at stream gages (Tables 3-2, 3-4, & 3-5) -1.4" / 30 minutes - 10-year flow rate • Significant overtopping of Green roadway crossings possible. • Washes overtop Orange roadway crossings at depth of 6" or more. • Roadway closures required at impassable Green and Orange crossings. • Potential for property damage exists. • Initiate CENS message modeled after example script in Appendix.
RED ALERT	**Red Alert** **Wash Name(s)** (begin time/ end time)	• Approximate 50-year flood event. • Greater potential for loss of life exists. • *Criteria*: Rainfall Rate Red 1.8"/ 30 minutes and/or Critical Flow Rates at stream gages (Tables 3-2, 3-4, & 3-5) • Significant overtopping of Green & Orange roadway crossings possible. • Washes overtop Red roadway crossings at depth of 6" or more. • Roadway closures required at impassable Green and Red crossings. • Potential for property damage exists.
BLUE ALERT	**Blue Alert** (begin time/ all clear)	• Dam emergency spillway discharges. • Serious potential for loss of life exists. • *Criteria*: Rainfall Rate Blue 5.2"/ 30 minutes and/or Critical Water Levels behind dam. • Serious potential exists for property damage downstream of the dam. • Refer to EAP for Adobe Dam
PURPLE ALERT	**Purple Alert** (begin time/ all clear)	• Dam failure possible. • *Criteria*: Observer reports dam failure and/or gage alarm triggered when rate of fall of the water level exceeds a pre-determined maximum rate. • Serious potential exists for property damage downstream of the dam. • Refer to EAP for Adobe Dam
ALL CLEAR	**All Clear** (effective time)	• Floods on impacted washes have dropped below critical levels. • Potential for additional flooding is minimal.

SECTION 6: ACTION PLANS

The following action items are specific to the Adobe FRP:

- FCDMC performs Flood Warning Branch responsibilities and actions according to their Flood Emergency Response Manual (FERM) and the Emergency Action Plan for Adobe Dam.
- The FCDMC Flood Warning Branch will notify specifically targeted floodplain residents via CENS in the event of significant flooding. Residents will be advised to elevate valuables and seek higher ground safely, if necessary.
- MCDEM will be contacted by FCDMC and direct countywide communication and response activities according to their Emergency Operations Plan and Emergency Response Manual.
- MCDOT is responsible for barricading known problem roadway crossings to the extent possible. Access to many impassable crossings will not be possible.
- City of Phoenix Streets Maintenance and Glendale Traffic Operations will be responsible for closure of affected roadways within their jurisdiction.
- Law enforcement agencies (MCSO, DPS, and COPPD) and fire departments (DMFD and COPFD) will respond to specific emergencies such as cars in flooded washes or resident assistance needs.
- ADOT or DPS will be responsible for I-17 closure in event of overtopping from Skunk Creek at the CAP.

Once a rainfall/ runoff event is occurring of sufficient magnitude so as to meet or exceed the established flood detection thresholds (Section 3.2), warning messages are issued (Section 5) using the information dissemination tools (Section 4.2) and communication flowpaths (Figure 4-1) previously established. Governmental and emergency response agencies participating in the Adobe FRP must implement their respective emergency response action plans. Participating agencies will follow the action plans described herein within the context of their own jurisdiction's incident command system.

6.1 Agency Action Plans

The agency action plans do not contain detailed operational procedures; rather, they provide an overview of technical support activities, communications, emergency operations and general responsibilities of each participating organization. Specific task assignments and responsibilities are described in these agencies' own emergency operations plans, dam owners' emergency action plans, and other supplemental documents. The FRP is intended to function largely as a stand-alone document. However, it is also to be added as an Appendix to the FCDMC Flood Emergency Response Manual and MCDEM Maricopa County Emergency Operations Plan and treated as a complementary document to these.

6.2 Evacuation Procedures

With the exception of the dam emergencies, evacuations are not generally a recommendation of the FRP. Evacuation requests and procedures will be coordinated by MCDEM as described in the Emergency Action Plans, FERM, and County EOP and ERM. Floodplain residents will be advised to "shelter in place" although this could mean seeking higher ground proximate to their residence. They are not encouraged to evacuate in their vehicles because this would likely place them in greater danger given the numerous impassable roadway drainage crossings throughout the area.

The NWS, FCDMC, and MCDEM will provide timely weather information and flood warning messages to residents to the best of their ability using currently available technology. Residents are advised that prediction of flash floods is complex and conditions can change very rapidly. Residents have a responsibility to do what they can to remain alert for changing flood conditions impacting their residences by using NOAA Weather Radios, commercial radios, television, and/or the internet. They should also closely monitor local conditions around their residences. When rainfall increases rapidly or flood conditions worsen significantly, residents should use common sense and seek high ground even if they have not received flood warning messages.

6.3 Post-Flood Actions

The FRP is intended to function independently as a stand-alone document, and to be added as an Appendix to the FCDMC Flood Emergency Response Manual and MCDEM Maricopa County Emergency Operations Plan (2002). Post-flood action protocols, as addressed in the FCDMC and MCDEM emergency response and emergency operations documents, are incorporated by reference herein to this Flood Response Plan. Post-flood actions include, but are not limited to, criteria for re-

occupation of structures, an After-Action Report, relations with the news media, and government assistance for flood victims (both private and agencies). Refer to the cited documents for further information.

SECTION 7: IMPLEMENTATION

This section of the FRP describes the training, exercises, and update requirements of the FRP. These requirements, as recommended in this section, should be reviewed annually to take into account future development, changes in land use, changes in population, advances in communication and sensing technology, and the organization of the identified agencies and community. Any changes to the FRP should be communicated to all participating agencies and residents in the warning area.

7.1 Training

FRP training participants should include the agency stakeholders responsible for developing flood information, the emergency response agencies responsible for carrying out the action plans, the shelter site personnel, and the residents responsible for responding to evacuation notifications.

The water resource and emergency response agencies training requirements will be met by participation in annual exercises described in Section 7.2. Specialized training may be required for DMFD, MCDOT, MCSO, MC Parks, and/or COP personnel to familiarize themselves with the structure of the FRP and to maintain proficiency with any activities unique to carrying out their responsibilities as outlined in the action plan. Listing the training requirements of each agency is beyond the scope of this FRP; however, the identification of the need for this training is not. It is recommended that each agency establish a means of ensuring that any extra training in response to flooding events is provided on a periodic basis and is adequately documented.

The residents included in the FRP CENS notification areas should receive instructions on the structure of the FRP, interpretation of the warning messages, and emergency response procedures. A public information program is recommended as described in Section 4.4.2.

7.2 Flood Exercises

The scope, temporal and spatial extent of flood exercises should be varied to develop and maintain competency in using the decision-making tools and information dissemination equipment, and to maintain interest and communications among the agencies and residents. The agencies that should be represented are those listed in Table 4-1. The following elements should be considered in formulating a program of FRP exercises:

1. The spatial extent of the exercises should be varied. Flash flood exercises can be conducted on a wash system-specific basis or the spatial coverage may extended to include all of the Adobe FRP watersheds. Similarly, the FRP may be incorporated into regular County-wide flood exercises including drills for the dam EAPs. The FRP should be exercised annually for at least some of the Adobe area watersheds and every three years as part of a County-wide flood exercise.

2. The exercises should vary temporally. The exercise can be held in alternating years during November or December to test the robustness of the FRP for winter storm flooding and during May or June to test the FRP for monsoon thunderstorm flooding.

3. The scope of the exercises should vary so that those involved in the FRP implementation become familiar with their roles and responsibilities. Exercise formats may include the following:
   - *Orientation Seminar.* This seminar will bring together those with a role or interest in the FRP to discuss the plan and gain familiarity with the various products/ decision aids, roles and responsibilities, and implementation procedures.
   - *Drills.* A low level exercise involving a test of the procedures required for an actual emergency action. A pre-determined exercise could be prepared by the FCDMC and conducted without prior knowledge of the other participating agencies.
   - *Tabletop Exercise.* A higher level exercise which involves a meeting of stakeholder agencies to look at simulated emergency events and discuss procedures to be taken.
   - *Functional Exercise.* This exercise involves a simulated severe flood event and requires the local and regional emergency management personnel to act out their roles without the commitment of equipment in the field.
   - *Full Scale Exercise.* This is a field exercise which involves a complete simulation of a severe flood event and evaluates all facets of the emergency management system.

4. Floodplain residents should receive mailers in advance of summer monsoon season and/or as part of NWS Flash Flood Awareness Week. Local newspapers could also include press releases about the FRP in conjunction with the mailers. Activities with local schools could also bring home the message to residents beyond those living within the floodplain.

7.3 FRP Updates

The FRP should be updated annually for changes in procedure and coverage due to communications upgrades, MSP/NWS forecast enhancements, changes in the flood detection network, changes in agency responsibilities, and/or population changes. The update should be conducted annually during April and May to insure necessary changes to the FRP are made before the active summer monsoon season. All FRP updates should be mailed out to agencies and individuals that receive copies of the FRP.

The following verification and update activities should be conducted:

- The National Weather Service and District MSP should verify available products.
- Radio frequencies, telephone, and fax numbers should be tested to see if changes have been made since the last operational season. Agency and resident contact numbers should be verified.
- See if any constructed upgrades have been made to roadway crossings. Several components of the ADMP Recommended Alternative address improvement of roadway drainage crossings. In particular, New River Road at Skunk Creek and Rodger Creek and Desert Hills Drive at Skunk Creek are identified as locations for new or upgraded crossings. In addition, 24th Street along Apache Wash is targeted for realignment out of the floodplain. An extension of the levees along Skunk Creek will prevent overtopping of I-17. Channel improvements upstream of Pinnacle Peak Road will prevent overflows at the intersection of Pinnacle Peak Road and 35th Avenue.
- Add cell phone number requests to the letter to floodplain residents interested in receiving CENS warnings to their cell phones once the wireless CENS capability comes on-line.

7.4 FRP Follow-Up

The following tasks are recommended to enhance the implementation of the FRP:

- A distribution list of agencies receiving the FRP materials is recommended. The list should be updated as revisions and/or amendments are issued.
- The enhancements to the flood detection network described in Section 3.4 should be prioritized and implemented as soon as possible. The FRP as written depends on these new stations.

- Development of an Internet web page is recommended to post flood-related messages and to make FRP materials directly available to the public. The deliverables for the current project include digital files of all FRP materials in pdf format to facilitate the development of a suitable web page.
- As described in Section 2.2.3, if a structure was located planimetrically within the 100-year floodplain limits, then it was considered affected by flow events above the Orange Alert level. Field surveys of finished floor elevations for some of these structures have indicated that they are high enough to prevent water from entering the structures. In addition, the frequency of inundation for those in the floodway have been previously determined. If a comprehensive evaluation were made, the warning levels could potentially be more finely segregated.
- Details of funding arrangements for payment of CENS message launches needs to be worked out.
- Flood Warning Branch personnel need to undergo training with Phoenix Fire Alarm (Liz Hunt) to facilitate smooth activation of CENS message launch requests through MCSO.
- Some testing of the CENS warning to a sample area(s) should be considered.

SECTION 8: LIMITATIONS

The limitations of the technical foundation of the FRP are those common to all hydrologic and hydraulic analyses. There are inaccuracies inherent in watershed modeling to estimate discharge values and in step-backwater computer models to estimate water surface elevations. Engineering judgment is used in estimating various input parameters to these models, such as loss parameters, routing variables, and roughness coefficients. Topographic mapping, though prepared to acceptable standards, also introduces error in measurements.

The operation of the flood warning system is predicated upon accurate measurement of rainfall and streamflow by the gages comprising the flood detection network. Known inaccuracies are introduced in measurements of rain by the gages due to uncontrollable variables such as wind speed and direction. The variability of precipitation further complicates the estimation of accurate modeling results. Similarly, measurement of streamflow can be inaccurate due to changes in channel conditions that render the rating curves inaccurate.

The FRP flood detection criteria analyses, roadway crossing impassability assessment, and floodplain residence identification assumes that the system functions as designed (e.g., no clogged culverts) and that the previous studies are correct (e.g. floodplains delineated properly, n-values do not change, etc.). Further, the 0.5 foot passability criteria used to develop the flood alert priority for roadway crossings is not necessarily applicable to all vehicles. Larger vehicles used by emergency responders (e.g., fire engine trucks) may safely pass some crossings indicated as impassable. However, extreme caution is warranted as other factors affecting roadway passability, such as road surface conditions or erosion of the roadway itself, may not be discernable beneath the floodwaters. Data and information dissemination technology sometimes breaks down stopping the flow of gage data and impairing communications amongst emergency responders.

The CENS system also has inherent limitations. In particular, the resident must have a phone, receive and listen to the message, and react to the message. At the present cell phones are not part of the CENS system database, but can be added as part of a static call list. People with dialup service to the internet without an external voicemail system could also fail to receive a message. Also, because of the nature of the CENS polygon definition procedure, the polygons shown in this FRP are approximately those in the CENS system, not precisely the same.

All of the above combine to produce results that are approximately correct, but exactly inaccurate. The users of this FRP should keep these known limitations in mind.

SECTION 9: CITED REFERENCES

Flood Control District of Maricopa County, July 31, 2002, Standard Operation Procedure, Maricopa County Flood Forecasts/Warnings

JE Fuller/ Hydrology & Geomorphology, Inc., 2005, Emergency Action Plan for Adobe Dam, prepared for Flood Control District of Maricopa County, under contract FCD 2002C039, Work Assignment No. 5, Jan. 2005.

JE Fuller/ Hydrology & Geomorphology, Inc., 2004, Adobe Dam / Desert Hills ADMP Alternatives Report, Part 8, Volume 2, prepared for Flood Control District of Maricopa County, under contract FCD 2002C001.

JE Fuller/ Hydrology & Geomorphology, Inc., 2003, Lower Skunk Creek Hydrology, Adobe Dam / Desert Hills ADMP, Part 3, Volume 4, Aug. 2003.

Maricopa County Department of Emergency Management, 2002, Maricopa County Emergency Operations Plan.

Tetra Tech, Inc., 2002, Floodplain Delineation Study for Skunk Creek between the CAP and Happy Valley Road, Two Dimensional Hydraulic Model, prepared under FCDMC contract FCD2000-C016, June 2002.

U.S. Army Corps of Engineers, Los Angeles District, 1982, Gila River Basin, New River and Phoenix City Streams, Arizona, Design Memorandum No. 2, Hydrology, Part 2, 1982.

APPENDIX

Example of CENS Script

This is the Flood Control District of Maricopa County please stand by for an emergency message.

Este es El Districto de Control de la Inundacion del Condado de Maricopa. Por favor espere para un mensaje de emergencia.

The Flood Control District of Maricopa County has issued an Orange Alert for (*Wash Name*) from (*begin time*) to (*end time*). Residents in floodplains along (*Wash Name*) are advised to take flood emergency actions. Persons in affected areas should elevate valuables at their residences and seek high ground while avoiding areas of flowing water. Do not get in your car and drive.

El Districto de Control de la Inundacion del Condado de Maricopa ha publicado una alarma anaranjada para (Wash Name) de (begin time) a (end time). Residentes en terreno aluvial adelante de (Wash Name) se aconsejan tomar medidas de urgencia de inundacion. Las personas en areas afectadas deben elevar los objetos de valor en sus residencias y buscar la alta tierra mientras que evitan areas de aguas corriente. No se meta en su coche y no conduzca.

Example letter to residents within CENS notification areas in English

Dear Resident,

This letter is being sent to you by the Flood Control District of Maricopa County (District) because your home has been identified as lying within or near to a flood vulnerable area. The District has recently completed a Flood Response Plan (FRP) as part of the Recommended Alternative for the Adobe Dam/ Desert Hills Area Drainage Master Plan (ADMP) for your area. One of the elements of the FRP is a targeted telephone-based emergency contact system. You may have heard recently about the new Community Emergency Notification System (CENS). The CENS service functions in effect as a reverse 911 system. That is, the Central 911 Dispatch Center can call large numbers of telephones simultaneously in the event of an emergency to provide timely information to citizens in the community.

The FRP has identified CENS as a means to contact you at your home in the event of a significant flood emergency in your area. If you are called you will hear a pre-recorded voice message with information similar to the following. Note the message is repeated in English and Spanish so most residents will understand the message content.

> *This is the Flood Control District of Maricopa County please stand by for an emergency message.*
>
> ***Intro in Spanish***
>
> *The Flood Control District of Maricopa County has issued an Orange Alert for* (Wash Name) *from* (begin time) *to* (end time). *Residents in floodplains along* (Wash Name) *are advised to take flood emergency actions. Persons in affected areas should elevate valuables at their residences and seek high ground while avoiding areas of flowing water. Do not get in your car and drive.*
>
> ***Message in Spanish***

The CENS service works with landline phones; that is, cell phones will not be called in the event of an emergency. If an answering machine picks up the call, a message will be left. If there is no answer, the CENS service will attempt the call a total of three (3) times before abandoning the call.

There are other ways besides CENS for you to stay informed about flood emergencies in your area. You can monitor television, radio, and the Internet for National Weather Service and District flood watches and warnings. Always be on the alert when rainfall is occurring in your area. You should plan in advance what actions you will take in the event of a flood emergency in your area. Remember, the best advice is for you to seek high ground in the immediate vicinity near your home. **DO NOT get in your car and drive. Most roadways in your area will be impassable due to flood waters.**

Please contact the District at (602) 506-1501 if you have questions or need more information.

Example letter to residents within CENS notification areas in Spanish

Estimado Residente,

Esta letra le esta siendo enviada por el Distrito de Control de la Inundacion del Condado de Maricopa (Distrito) porque su hogar se ha identificado dentro o cerca de una area vulnerable de la inundacion. El Districto ha terminado recientemente un Plan de la Respuesta de la Inundacion (Flood Response Plan (FRP) como parte de Alternativa Recomendado para Adobe Dam/Desert Hills Area Drainage Master Plan (ADMP) para su area. Uno de los elementos de FRP es un sistema apuntado del contacto de la emergencia de telefono-base. Usted pudo haber oído recientemente sobre el nuevo Sistema de la Notificacion de la Emergencia de la Comunidad (en ingles Community Emergency Notification System (CENS). El servicio de CENS funciona en efecto como un sistema de opuesto 911. Es decir, el Central 911 Dispatch Center puede llamar una gran cantidad de telefono simultaneo en un evento de una emergencia para proveer la informacion instante a los ciudadanos en la comunidad.

El FRP ha identificado CENS como los medios de contacto con su hogar en el evento de una emergencia significativo de la inundacion en su area. Si le llaman usted oira un mensaje de una voz grabada con la informacion similar al siguiente. Observe el mensaje se repite en inglés y el español la mayoría de los residentes entendera tan el contenido del mensaje.

Intro en inglés

Este es El districto de Control de la Inundacion de Maricopa por favor espere para un mensaje de emergencia.

Mensaje en inglés

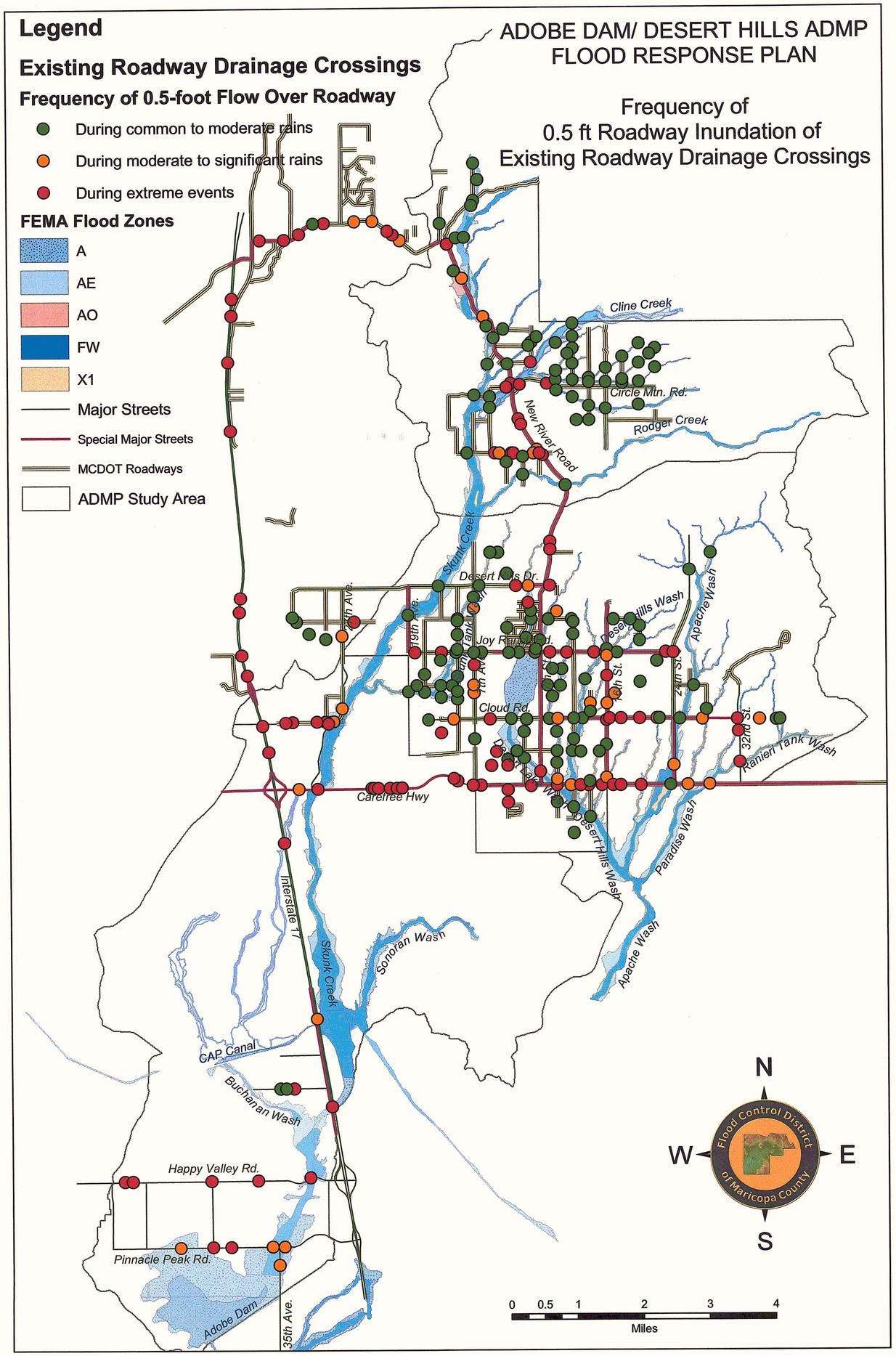
El Districto de Control de la Inundacion del Condado de Maricopa ha publicado una alarma anaranjada para (Wash Name) de (begin time) a (end time). Residente en terreno aluvial adelante de (Wash Name) se aconsejan tomar medidas de urgencia de inundacion. Las personas en areas afectadas deben elevar los objetos de valor en sus residencias y buscar la alta tierra mientras que evitan areas de aguas corriente. No se meta en su coche y no conduzca.

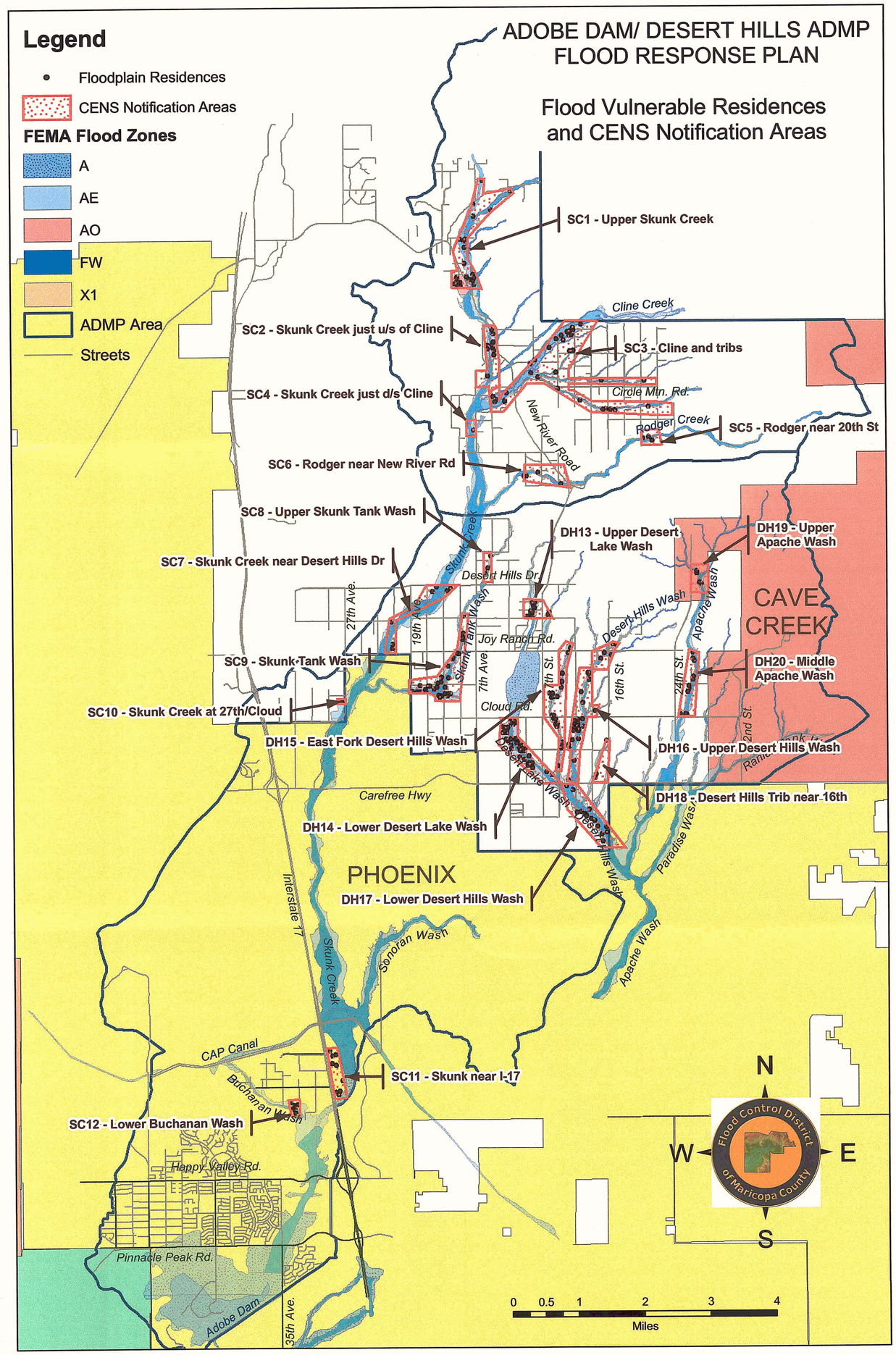
El servicio de CENS trabaja con los telefonos de linea; es decir, los telefonos de celular no seran llamados en el evento de una emergencia. Si contesta una grabacion automatica un mensaje sera dejado. Si no hay respuesta, el servicio de CENS

intentera la llamada al total de tres (3) veces antes de abandonar la llamada.

Hay otras maneras ademas de CENS para que usted este informado sobre emergencias de la inundacion en su area. Usted puede mirar la televsion, radio, y el Internet para las advertencias del tiempo de la inundacion Nacional del Servicio (National Weather Service) y del Districto. Este siempre alerto cuando la precipitacion esta ocurriendo en su area. Usted debe planear por adelantado que acciones usted tomara en el evento de una emergencia de la inundacion en su area. Recuerde, el mejor consejo esta para que usted busque la tierra mas alta en el lugar mas cerca de su casa. **NO se meta en su coche y no conduzca. La mayoría de los caminos en su area seran inaccesible debido a las aguas de la inundacion.**

Llame por favor el Districto en (602) 506-1501 si usted tiene preguntas o necesita mas informacion.


ADOBE DAM/ DESERT HILLS ADMP
FLOOD RESPONSE PLAN
Frequency of
0.5 ft Roadway Inundation of
Existing Roadway Drainage Crossings
Legend
Existing Roadway Drainage Crossings
Frequency of 0.5-foot Flow Over Roadway
During common to moderate rains
During moderate to significant rains
During extreme events
FEMA Flood Zones
A
AE
AO
FW
X1
Major Streets
Special Major Streets
MCDOT Roadways
ADMP Study Area
Cline Creek
Circle Mtn. Rd.
Rodger Creek
New River Road
Skunk Creek
Desert Hills Dr.
Joy Ranch Rd.
Cloud Rd.
Carefree Hwy
Desert Hills Wash
Apache Wash
Paradise Wash
Ranier Tank Wash
Interstate 17
Sonoran Wash
CAP Canal
Buchanan Wash
Happy Valley Rd.
Pinnacle Peak Rd.
Adobe Dam
35th Ave.
N
W
E
S
Flood Control District of Maricopa County
0 0.5 1 2 3 4
Miles


ADOBE DAM/ DESERT HILLS ADMP
FLOOD RESPONSE PLAN
Flood Vulnerable Residences
and CENS Notification Areas
Legend
Floodplain Residences
CENS Notification Areas
FEMA Flood Zones
A
AE
AO
FW
X1
ADMP Area
Streets
SC1 - Upper Skunk Creek
SC2 - Skunk Creek just u/s of Cline
SC3 - Cline and tribs
SC4 - Skunk Creek just d/s Cline
SC5 - Rodger near 20th St
SC6 - Rodger near New River Rd
SC8 - Upper Skunk Tank Wash
SC7 - Skunk Creek near Desert Hills Dr
DH13 - Upper Desert Lake Wash
DH19 - Upper Apache Wash
DH20 - Middle Apache Wash
SC9 - Skunk Tank Wash
SC10 - Skunk Creek at 27th/Cloud
DH15 - East Fork Desert Hills Wash
DH16 - Upper Desert Hills Wash
DH18 - Desert Hills Trib near 16th
DH14 - Lower Desert Lake Wash
DH17 - Lower Desert Hills Wash
SC11 - Skunk near I-17
SC12 - Lower Buchanan Wash
CAVE CREEK
PHOENIX
Cline Creek
Circle Mtn. Rd.
Rodger Creek
New River Road
Skunk Creek
Desert Hills Dr.
Joy Ranch Rd.
Cloud Rd.
Carefree Hwy
Desert Hills Wash
Apache Wash
Paradise Wash
Interstate 17
Sonoran Wash
CAP Canal
Buchanan Wash
Happy Valley Rd.
Pinnacle Peak Rd.
Adobe Dam
35th Ave.
N
W
E
S
Flood Control District of Maricopa County
0 0.5 1 2 3 4
Miles

Legend

Existing Roadway Drainage Crossings

Recurrence Interval of 0.5' Inundation

- 1 - 10 years
- 11 - 50 years
- > 50 years
- MCDOT Roadways

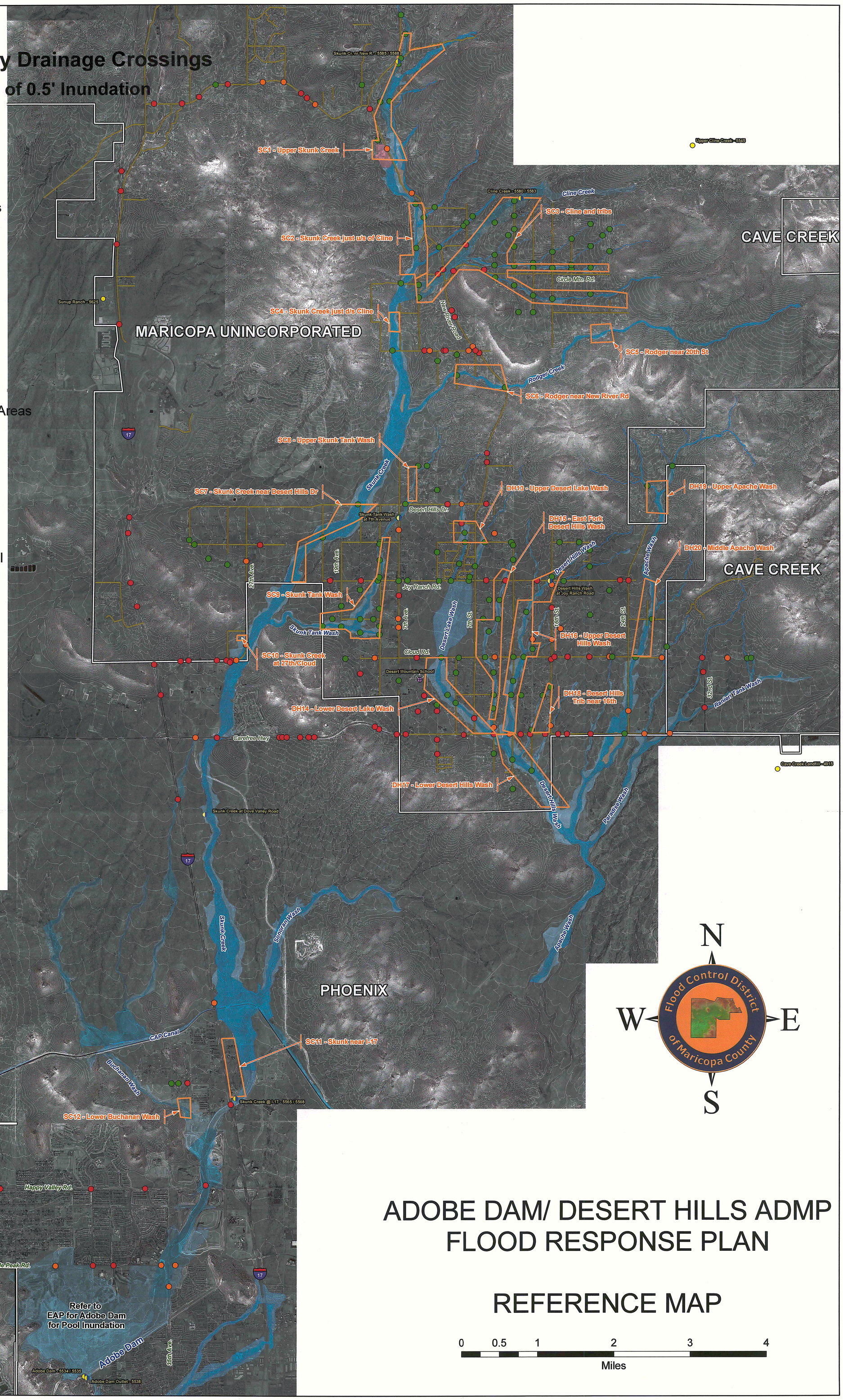
FEMA Flood Zones

- A
- AE
- AO
- FW
- X1
- CENS Notification Areas

ALERT Gages

Station Type

- Precipitation
- Weather Station
- Precip./Water Level



N

W E

S

ADOBE DAM/ DESERT HILLS ADMP FLOOD RESPONSE PLAN

REFERENCE MAP

0 0.5 1 2 3 4

Miles